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Assessing Physical Impacts of Water Quality Projects

Strategic Planning & Policy Analysis Staff Report

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Abstract

This report presents the approach being followed to assess the ability of USDA projects to protect or improve water quality from agricultural nonpoint source pollution and to document that protection or improvement. The approach emphasizes training project staffs in the use of monitoring and physical process simulation techniques to better document progress. The 16 projects selected for the Assessment suggest the variety of agricultural nonpoint source pollutants affecting the Nation's waters, major types of management and land treatment practices being promoted to protect or improve water quality, and the analytic tools being used to document progress.

Introduction

Evaluation Mandate

The USDA Water Quality Program Plan requires an evaluation of the performance of this FY 1990-94 Program. To implement the Program Plan, the Education, Technical, and Financial Assistance Committee (ET&FA) of the USDA Working Group on Water Quality developed the conceptual evaluation framework. Three USDA agencies -- Economic Research Service (ERS), Extension Service (ES), and Soil Conservation Service (SCS) -- are responsible for evaluating the ET&FA program from a national perspective. This evaluation has four major components: I - Initial Organization and Implementation; II - Producer Adoption; III - Physical Impact Assessment; and, IV - Economic Assessment.

This report presents the approach being taken in Component III - the Physical Impact Assessment (Assessment). The report gives a brief overview of the full ET&FA evaluation, the Assessment approach, a description of the 16 projects participating in the Assessment, technical assistance plans of the Assessment team for FY 1992, and an outline of the Interim Report (March 1993).

Evaluation Components

I Organization and Initial Implementation: ES took leadership in the first component: Assessment of the Organization and Initial Implementation of the Eight Demonstration Projects Approved in FY 1990. Kay Rockwell and DeLynn Hay, Cooperative Extension, University of Nebraska, acted as co-principal investigators. The Nebraska team visited each project to assess project plans, coordination and cooperation among local-state-federal agencies, and early implementation. Agency staff were the main data source. The final report was published in January 1992.

II Producer Adoption: ES is taking leadership in the second component: Evaluation of Producer Adoption of Water Quality Measures in the first eight Demonstration Projects. Peter Nowak, Department of Rural Sociology, University of Wisconsin, is the principal investigator. Producers in 15 areas (each of the eight projects and seven control areas) will be surveyed in 1992 and 1994 by mail questionnaire. The purpose is to: a) make a statistically valid estimate of the acceleration of adoption of measures to protect or improve water quality; and b) determine the influence of the demonstration and of other factors to rates of adoption.

III Physical Impact Assessment: SCS is taking leadership in the third component: Physical Impact Assessment (Assessment). The purpose is to assess the ability of the first eight Demonstration Projects and eight selected Hydrologic Unit Areas to protect or improve water quality from agricultural nonpoint source pollution and to document those effects. Assessment data will be provided to ERS for Component IV.

Members of the Assessment team are

- Ray H. Griggs, Agricultural Engineer, Blackland Research Center, Texas A & M University, Temple, Texas. Ray is responsible for: a) assisting project staffs select and use physical process simulation models; and b) assessing progress in use of simulation models.

- Donald W. Meals, Research Associate, School of Natural Resources, University of Vermont, Burlington, Vermont. Don is responsible for: a) helping project staffs understand the complexities of monitoring water quality and agrichemical management; b) relating changes in that management to water quality; and c) assessing progress in use of monitoring.

- John D. Sutton, Agricultural Economist, SCS, Strategic Planning and Policy Analysis Staff, Washington, D.C. John has overall responsibility for the Assessment. Among other things, this involves helping project staffs automate data management and coordinating activities of university cooperators with on-going USDA technical assistance and program activities.

IV Economic Cost-Effectiveness and Benefits: ERS is taking leadership in the fourth component: Economic Cost-Effectiveness and Benefits. The purpose is to measure

economic net benefits of reasonable alternative water quality activities. The projects to be studied will be among the 16 participating in the Physical Impact Assessment.

Key Aspects of the Assessment

The Assessment team will analyze annual reports from 16 projects approved in FY 1990, examine the data and methods used by project staffs to document progress in their annual reports, and draw implications for future USDA water quality programs. The approach conforms to the conceptual framework outlined in the USDA Program Plan and in the ET&FA Monitoring and Evaluation Strategy (see Appendix).

Annual Project Reports

The Assessment team will base its reports on the data and analyses developed by project staffs. This is possible since the ET&FA Strategy requires all projects to monitor and evaluate their own performance in their Annual Project Reports. The team played a significant role in designing the required format and content of these Reports.

All reports are to document one or more of three major types of physical impacts. They are:

o Changes in use and application of agrichemicals and animal waste relative to project goals; and

o Predicted (from physical process simulation models) reductions in agrichemical losses beyond the edge of the farm field or the bottom of the crop root zone relative to project goals; and/or

o Monitored change in groundwater and/or surface water quality resulting from treatment activities relative to project goals.

Technical Assistance

In large degree, the credibility of the Assessment will depend upon the quality of the work done by the selected projects. To ensure a high level of objectivity and credibility in Annual Reports prepared by project staffs, the team will offer training and/or technical assistance in the selection and use of the appropriate analytical methods and tools for documenting performance. These methods and tools include those for: a) data management; b) establishing baseline water quality and agrichemical use and management; c) monitoring change in water quality or water quality indicators and in agrichemical use and management; and d) simulating potential change in water quality indicators. Of course, project staffs remain responsible for helping producers to implement effective practices or systems that protect water quality and for documenting project progress in achieving goals.

Baseline Conditions

Pre-project conditions from which project staffs will measure progress toward project goals are "baseline" conditions. Project staffs will estimate baseline conditions for water quality, or water quality indicator, and for the nonpoint agricultural sources contributing to the water quality problem. Staffs will also state project goals for improvement over the baseline conditions.

In assessing ability to protect or improve water quality, the Assessment team will take into consideration that establishing quantitative, objective estimates of baseline conditions is possible but not necessarily easy or straightforward. Several reasons are suggested:

1) Lack of standards for what constitutes a water quality problem or unacceptably high level for a water quality indicator;

2) Insufficient time-series data on water quality or indicators and/or on local weather;

3) An incomplete understanding of causality over time and space between application of agrichemicals and water quality;

4) Lack of time-series data on agrichemical use and management.

In spite of such factors, it is possible and/or necessary to:

a) Develop objective baseline estimates from multiple sources of varying quality and to cite these sources;

b) Revise these estimates during the course of the projects as knowledge is gained by working with producers and interpreting data from monitoring and simulation models;

c) Document quantitative progress from the baseline conditions using data from monitoring (water quality

and agrichemical management) activities and/or physical process simulation models.

Other Programs/Projects

Isolating the effect of a project on change in water quality is confounded by the ongoing presence in many projects of significant water quality programs of other Federal and State agencies. Funds and staff are often co-mingled. A satisfactory means to resolution of this problem has not yet been developed. The Producer Adoption survey (Component II) is expected to cast some light by determining the statistically important factors causing adoption of measures in the eight Demonstration Projects.

Differences Between HUAs and DPs

Annual Project Reports vary between Demonstration Projects (DP) and Hydrologic Unit Area (HUA) due to conceptual differences between the two types of projects. HUAs must be located only in areas that States have identified, under section 319 of the Water Quality Act, as having significant impairment of water quality by agricultural nonpoint sources. While nonpoint source problems are potentially important in a DP, they need not have been identified as a high priority problem by the State. Whereas HUAs are, by definition, a watershed or aquifer-recharge area, a DP may or may not be a hydrologic unit.

In the HUAs, SCS, ES, and cooperating agencies emphasize planning and implementing practices and systems already known to protect or improve water quality. In contrast, DPs demonstrate the effectiveness of often relatively new practices and in so doing promote practice adoption. Project staffs concentrate their efforts on the demonstration sites and activities.

DP staff may estimate physical effects only on demonstration sites. DP staff may have only limited data on practice adoption by producers who do not receive direct assistance but who may adopt based on knowledge gained from attending field days, farm tours, and other demonstration activities. Data on total acreage receiving improved agrichemical management may thus be less complete for DPs than for HUAs.

The Assessment will rely on the Producer Adoption (Component II) to estimate the extent of adoption of the most important practices in the eight DP projects. Those results, which will also be available to project staffs, together with monitoring and simulation results may make it possible to generalize some DP-wide physical impacts. The Producer Adoption study should also indicate the reasons for and against adoption of practices in the eight DPs.

Sixteen Projects Selected

The process used to select projects involved:

- o Accepting the USDA Program Plan requirement to evaluate the eight DPs approved in FY 1990.
- o Developing criteria for selecting HUAs with ASCS, ES, ERS, and SCS staff and requesting input from the USDA Water Quality Working Group's Data Base and Evaluation Committee. The criteria were:
  - o Type of groundwater and/or surface water body threatened by agricultural nonpoint sources of pollution.
  - o Project focus on improving nutrient (organic as well as inorganic) management and/or pesticide management.
  - o Presence of either major agricultural commodities and/or livestock (poultry, dairy, beef cattle, hogs) operations.
  - o Non-irrigated as well as irrigated cropland.
  - o Presence of water quality monitoring.
  - o Knowledge of or receptivity to using physical process simulation models.
- o Requesting HUA nominations from HUA Program managers and SCS National Technical Centers.
- o Reviewing project proposals and FY 1990 plans of operation for nominated projects, discussing the Assessment with project coordinators, making an initial selection, reviewing and revising the selection with HUA Program managers, and presenting the final list to the ET&FA Committee.

In terms of agricultural activities and nonpoint source pollutants, the 16 projects fall into two major groups and two other groups.

The first group has eight projects. See table 1. It is characterized primarily by concern over contamination of

surface water by runoff of nutrients from cropland (non-irrigated) and livestock production. Project staffs expect to achieve improvements by causing adoption of improved management of nutrients, pesticides, and sediment. Improvements will be measured from baseline conditions established either by special surveys (in six of the eight projects), recent studies, and by judgement of CES, SCS, and State agency staff familiar with the project area.

The second group has six projects. It is characterized primarily by concern over contamination of shallow groundwater and associated surface waters by leaching of nitrates and pesticides from irrigated cropland. Livestock and poultry operations are significant nonpoint nutrient sources in three projects. Project staffs expect to achieve improvements by causing adoption of improved management of irrigation water, nitrogen, pesticides and animal wastes. Improvements will be measured from baseline conditions established by special surveys (in five of the six projects), previous and recent studies, and judgement of agency staffs.

Two projects do not fit well into either group. The Texas project has both a surface water and groundwater concern, agriculture is primarily rangeland, and nutrients and pesticides are the primary pollutants. The California project has a surface water quality problem, agriculture is solely irrigated rice, and the pollutant of concern is a rice herbicide.

Table two summarizes the projects in terms of water bodies of concern, type of agricultural nonpoint source pollutants, and type of water quality monitoring. The table shows that of the 16 projects,

- o Surface water quality is actually or potentially impaired in a river or stream in eight projects, in a lake (six), in an estuary (one);
- o Groundwater quality is actually or potentially impaired in a shallow aquifer in nine projects, in a deep aquifer (four);
- o Eight projects have irrigated cropland, eight have dairy or beef cattle operations, six have poultry or hog operations;
- o Nitrates are cited as an actual or potential problem in 13 projects, phosphates in 9, sediment in 10, pesticides in 12, and animal waste in 11 projects. (Among all 45 FY 1990 projects, about 30 projects listed nutrients, pesticides, and sediment as a pollutant of concern and about 20 listed animal waste.

Table 1 -- Projects selected

Hydrologic Unit Areas	Demonstration Projects
Group I	
AL - Sand Mountain/Lake Guntersville	MD - Monocacy River
IN - Upper Tippecanoe	NC - Herrings Marsh Run
MI - Sycamore Creek	WI - East River
NY - East Sidney Lake	
UT - Little Bear River	
Group II	
DE - Inland Bays*	FL - Lake Manatee
IL - Illinois River Sand	MN - Anoka Sand Plain
OR - Ontario	NE - Mid-Nebraska
Group III	
	TX - Seco Creek
Group IV	
	CA - Rice Herbicide

* The Inland Bays HUA may also fit in Group I

Assessment Team Activities and Plans

Major Activities in FY 1991

Establish Cooperative Agreements between SCS and Texas A&M University and between SCS and the University of Vermont.

Design and implement a process to select Demonstration Projects and Hydrologic Unit Areas for the Assessment.

Work with national headquarters SCS and Extension Service staff to develop an Annual Project Report format that emphasizes: a) statement of specific, measurable water quality goals; b) presentation of baseline conditions for agrichemical management and water quality; c) development of a strategy to monitor and evaluate progress; d) use definitions and measurement units that are consistent across different projects.

Table 2 -- Characteristics of the Sixteen Projects

	8 Demonstration Projects								8 Hydrologic Unit Areas								
	MD	WI	FL	NC	MN	NE	TX	CA	NY	DE	AL	MI	IN	IL	UT	OR	Total
<u>Water type</u>																	
Surface Water	X	X	X	X			X	X	X	X	X	X	X		X	X	13
River/stream	X	X		X			X	X				X			X	X	8
Lake/reservoir		X	X						X		X		X		X		6
Estuary										X							1
Ground water	(X)	(X)	X	X	X	X	X			X		(X)	X	X		X	12
Deep		(X)				X	X					(X)					4
Shallow	(X)	(X)	X	X	X					X			X	X		X	9
<u>Agriculture enterprise</u>																	
Irrigated cropland			X		X	X	X	X						X	X	X	8
Dairy/Beef	X	X		(X)					X			X	X		X	X	8
Poultry/Hogs	X			X						X	X	X	X				6
<u>Pollutant</u>																	
Nitrates	X	X	X	X	X	X	X			X	X	X	X	X		X	13
Phosphates	X	X		X			X		X		X	X	X		X		9
Bacteria		X					X			X	X				X	X	6
Sediment	X	X		X			X		X		X	X	X		X	X	10
Pesticides	X	X	(X)	X	X	X	X	X				X	X	X		X	12
Animal Waste	X	X		X			X		X	X	X	X	X		X	X	11
<u>Monitoring type</u>																	
SWQ Monitoring		X	X	X	X			X	X	X	X	X	X	X		X	13
Storm events		X					X				X	X					4
Biomonitoring	X	X		X							X	X			X		6
GWQ Monitoring		X	X	X	X	X	X			X	X	X	X	(X)		X	12
Vadose zone			X		X											X	3

Note: items in parentheses are of secondary importance.

Visit or teleconference with staffs of all 16 projects to

a) Clarify Annual Project Report requirements;

b) Discuss monitoring and evaluation. This involved discussing

- o what is meant by "baseline conditions," identifying specific data elements to document those conditions, and adequacy of automated data entry and retrieval systems;
- o the importance of citing sources of baseline estimates;
- o how physical process simulation models can be useful in predicting relative changes in agrichemical movement off the farm field and below the bottom of the root zone when operators change crop and/or livestock management.
- o how to estimate project-wide water quality effects given the great variety of structural and management practices fully (and partially) implemented on different soils and in different locations relative to the water body of concern.

Establish working relationships with existing technical assistance and training programs of the SCS National Technical Centers.

Directly involve seven of the Assessment projects (AL, DE, MD, MI, TX, OR, UT) in the SCS Water Quality Model Evaluation.

Establish cooperation with the U.S. Geological Survey (USGS), both the Office of Water Quality and District groundwater specialists, to conduct the Assessment on those projects with significant groundwater concerns.

Training and Technical Assistance: Monitoring Water Quality and Land Management

Issues

Of the three general approaches available for evaluating the effectiveness of USDA water quality projects -- monitoring, modeling, and documenting changes in chemical inputs -- water quality monitoring is often preferable. Unvalidated water quality models can only provide suggestions of relative changes in response to treatment; documented reduction in chemical use can show only that water quality changes should occur. Only actual water quality monitoring data can document real change in the receiving water affected by agricultural nonpoint source pollution.

Water quality monitoring, however, is not simple, inexpensive, or easy. Some major nonpoint source monitoring efforts in other programs have yielded disappointing results due to inappropriate monitoring design, inadequate resources, unforeseen complexities in the natural system, and other factors. A number of issues must thus be considered, both in a general sense and with respect to current USDA DP and HUA projects, to promote effective use of available monitoring and interpretation of water quality data.

Resources available for monitoring

USDA-sponsored water quality monitoring was generally not included in the original DP and HUA project proposals because the ET&FA position was that other Federal and/or State agencies with monitoring expertise should design and conduct such monitoring. Budgetary shortfalls in some States have curtailed some State agency monitoring outlined in project proposals. Monitoring efforts developed for these projects are often taking place with minimal personnel, financial, and technical support. Efficiency of monitoring with severely limited resources is thus a major consideration.

Specificity of monitoring

In many cases, monitoring data from independent programs such as State ambient water quality networks or other Federal programs are available and will be applied to assessment to DP and HUA project impacts. While a wealth of data may be available from such sources, these independent monitoring programs were not, for the most part, specifically designed to detect or evaluate changes in water quality associated with the agricultural nonpoint source pollution projects. The data may not, therefore, be very useful in assessing project effectiveness. A State program to monitor water quality in a large estuary system, for example, may not have stations close enough to the project area to show meaningful response to treatments far up in the drainage basin. Critical evaluation of data from independent monitoring programs is therefore a crucial issue in this Assessment.

Lag time

Except in rare cases, some lag time between land treatment and water quality response is to be expected. This lag time may be a reflection of the hydrologic regime, such as very

slow groundwater movement through a regional aquifer, or it may be due to time required to flush accumulated pollutants through the system, such as phosphorus stored in lake sediments or soils. In either case, if lag time in response exceeds the duration of the project, even the most intensive monitoring program will not detect a change in water quality. Therefore, the nature and significance of lags in system response must be evaluated in each project so that a lack of quick improvement is not taken for failure of the project. This may be an important focus for the use of water quality models.

Hydrologic variation

In surface water systems, water quality is strongly influenced by seasonal and year-to-year variability in precipitation, runoff, and streamflow. If the effects of such variation are not accounted for in data analysis, erroneous conclusions may result. Declines in sediment load to a lake may result from drought, for example, rather than from improved agricultural management. Collection of additional data needed to account for hydrologic variability may be of value for some projects. Use of models may be particularly important in such situations.

Extrapolation of data from individual sites

Many projects rely on intensive monitoring of individual demonstration fields, farms, or BMPs. Assessment of project-level effectiveness will require extrapolation of such site-specific data to the watershed or waterbody level in order to project changes in water quality impairment. Such a process will be extremely difficult without two major foundations: (1) sufficient knowledge of the system to understand how pollutants are transported through the system and delivered to the receiving water; and (2) extensive data on the adoption, use, and management of the demonstrated practices across the watershed. One or both of these items may be critical issues in some projects.

Land treatment tracking

In order to relate changes in water quality to changes in agricultural management, the extent of adoption, use, and management of land treatments must be known. This is particularly true of practices that are primarily management based such as Integrated Crop Management (ICM) or animal waste management. Land treatment and agricultural management data are needed for all types of project evaluation, monitoring, modeling, or measurement of changes in chemical inputs. The need for land treatment data is especially great where data from a few field-scale monitoring sites must be projected to a basin scale. Few projects have emphasized detailed land treatment tracking in their work plans.

Training Plans

Consideration of the above issues should be incorporated into the evaluation process at the project level. To accomplish this, some form of technology transfer or training will be useful. The target audience will be SCS and Cooperative Extension Service (CES) staff responsible for project operation and reporting in each of the 16 projects. Options under consideration for training include regional workshops in association with the SCS National Technical Centers (NTC), satellite video seminars and teleconferences, and brief seminars combined with individual technical assistance during project site visits. Monitoring workshops may be combined with modeling workshops in some cases.

Training content and format are under development with the SCS NTCs and individual project staffs. Topics being discussed include:

- o Setting reasonable monitoring objectives.
- o Comparison of monitoring approaches (e.g. edge-of -field/bottom of root zone vs. BMP vs. watershed vs. receiving water) and relationship to impaired water quality
- o Monitoring designs -- experimental design
  - -- station location
  - -- sampling frequency
  - -- type of sampling
  - -- type of data collected
- o Physical/chemical/biological monitoring parameters
- o Data analysis and interpretation -- QA/QC
  - -- statistics
  - -- cause & effect
- o Land treatment tracking
- o Data management, reporting, and presentation

Because the DP and HUA projects are still in relatively early stages of implementation, the initial round of training will likely focus on evaluation of monitoring parameters and designs, strengthening of land treatment tracking efforts, and data management and reporting.

Training and Technical Assistance: Simulation Models

A variety of physical process simulation models are used in connection with water quality projects. The approach being followed is to first focus on developing a clear understanding of the water quality problem and how it is to be addressed, and only then focus on the degree to which models may be useful to document progress. It is possible that some project staffs may choose not to use simulation modeling but instead to rely solely upon water quality monitoring.

Normally, any particular model will not have been validated for the site-specific conditions found in a project area. Largely for that reason, models will be used to project long-term, relative changes in water quality indicator parameters. When appropriate, results from more than one model will be presented and compared. It is expected that project staffs will integrate model predictions with results from water quality monitoring to fully document progress.

Because project staffs rarely have had extensive experience with the major models and because of the complexity of the technical relationships within most of these models, training in FY 1992 will concentrate on how to build and input data sets (based directly on water quality practices installed) to the field-scale model(s) selected by them, how to run the model(s), and how to correctly interpret model results. Training will be expanded to watershed-scale models in FY 1993 in those projects where such expansion is appropriate.

Training plans are being developed with the SCS NTCs and with staff from each project. Selected observations from each project that will affect training content follow.

Training and Technical Assistance: Data Management

The 16 projects participating in the Assessment have been utilizing a variety of methods, including the SCS Computer Assisted Management and Planning System (CAMPS) and spreadsheets developed by the multi-agency project staffs, to record, retrieve, and manipulate data. In some projects, the lack of a fully automated data entry and retrieval system has made these tasks unnecessarily time-consuming.

SCS has mounted a major effort to automate all field offices in FY 1992-93 with the Field Office Computing System (FOCS). Capitalizing on that effort, the Assessment team initiated development software to automate data retrieval and table generation for water quality which would a) be compatible with FOCS, and b) be based on the data recording, retrieval, and reporting needs of the Assessment projects.

Outline of March 1993 Interim Report

A. Introduction

1. Water quality background conditions and nonpoint source pollutants.

2. Goals to protect/improve water quality.

B. Progress in FY 1991-92, by projects and/or project groups.

1. More effective agrichemical management.

a. Degree to which systems and/or practices installed were targeted to problem soils.
b. Comparison of project-reported improvements in organic and inorganic agrichemical use and management, including irrigation water management, to goals.
c. Issues relating to projects' abilities to target to problem soils and to practices having a relatively significant ability to reduce nonpoint source pollution.

2. Improvements in and issues remaining for data collection, entry, and retrieval both in terms of data quality and data management efficiency.

3. Comparison of simulated predictions and goals for protection of surface water quality: field-scale models.

a. Development in project staffs' capabilities to use models.
b. Reductions in movement of agrichemicals and sediment beyond edge-of-field compared to goals.
c. Issues relating to use of field-scale models.

4. Comparison of simulated predictions and goals for protection of surface water quality: watershed-scale models. NOTE: Most projects will emphasize use of field-scale models in FY 1992, some combination of field-scale and watershed-scale models in FY 1993-94.

a. Development of project staffs' capabilities to use models.
b. Reductions in movement of agrichemicals and sediment beyond edge-of-field compared to goals.
c. Issues relating to use of watershed-scale models.

5. Comparison of simulated predictions and goals for protection of groundwater quality.

a. Development of project staffs' capabilities to use models.
b. Reductions in movement of organic and inorganic agrichemicals below-the-root-zone compared to goals.
c. Issues relating to use of models for groundwater quality analysis.

6. Water quality monitoring.

a. Status of monitoring and evaluation programs.
b. Results of water quality monitoring and evaluation
1) Measured changes in water quality: site-level monitoring; watershed-level monitoring.
c. Ability of monitoring networks to detect changes in water quality and relate to agricultural management.
d. Development of project staffs' capabilities to use monitoring networks and data.
e. Needs to improve/change water quality monitoring and evaluation.
f. Issues relating to effective water quality monitoring to document protection from nonpoint sources.

C. Assessment Team plans for FY 1993-94 and the 1995 Final Report

1. Training/technical assistance in data management.

2. Training/technical assistance in simulation models and geographic information systems to estimate project-wide impacts.

3. Integration of model simulations with water quality monitoring and agrichemical management survey data to document progress.

4. Final Report Outline

Project Summaries

Group 1 Projects: Primarily Surface Water, Sediment, Nutrients, Nonirrigated Cropland & Livestock

Sand Mountain-Lake Guntersville HUA, Alabama

Abstract: This project focuses on a reservoir of high recreational value in a watershed dominated by livestock operations and cropland. The major water quality concern is lake contamination by nutrients and bacteria from animal waste and by sediments from eroding cropland. Improved animal waste and nutrient management and cropland erosion control practices will be implemented. The principal basis for assessment of project impact on water quality will likely be ambient surface water quality monitoring.

Introduction: This 400,000 acre HUA in northeast Alabama includes the Lake Guntersville Reservoir, the major source of water-based recreation in the area. Agriculture is composed of small livestock operations, primarily poultry and hogs; one-third of the project area is cropland, devoted to corn, soybeans, and potatoes.

Agricultural pollutants are linked to undersized swine waste lagoons, cropland erosion, and poultry operations (processing an estimated 9 million birds annually) which import feed from other States. Under baseline conditions, poultry operators spread 6-10 tons of litter annually (usually in one spring application) for average application rates of 345 lb/acre for nitrogen and 470 lb/acre for phosphorus. Most (90 percent) swine lagoons overflow during the wet season. Spreading lagoon waste is not common as it is relatively labor intensive for the amount of nutrients applied. Some 75 percent of the HUA's cropland erodes above "acceptable levels"; two-thirds of the cropland is tilled under systems that leave more than 15% residue. Many uses of Lake Guntersville, including public water supply, recreation, fisheries, and aesthetics are impaired by sediment, nutrients, and bacteria.

Groundwater contamination may also be a problem in the HUA, although it has not been well documented. Bacterial contamination has been recorded in a high percentage of area wells and much of the HUA has a high potential for nitrate leaching.

Project goals are to improve surface water quality, especially in Lake Guntersville. To achieve these goals, staff will implement improved animal waste management and erosion control.

Site Level Monitoring: There are numerous research and demonstration projects in progress, including constructed wetlands to treat agricultural wastewater, dead bird composting, use of broiler litter as fertilizer, and evaluation of the effects of no-till on water infiltration and soil chemistry. A constructed wetland system for treatment of swine waste is being evaluated in a TVA/SCS/Auburn University study. Input and output from the wetland are sampled for sediment, nitrogen, phosphorus, biological oxygen demand (BOD), and bacteria. Concentration data, estimates of mass flux through the system, and groundwater monitoring will provide an assessment of the effectiveness of this new practice.

In a joint USDA Agricultural Research Service (ARS) and Alabama Agricultural Experiment Station project, soil water use, infiltration rates, and soil physical/chemical properties are being evaluated under no-till cropland. Soil nitrogen content and depth of nitrate penetration are being assessed. Effects of rainfall quantity and duration on surface runoff volume are also under study. A companion study focuses on effects of broiler litter applications on nitrogen losses from no-till cropland.

Other studies will document the effects of poultry litter applications on cropland in the HUA. Soil sampling under pastures receiving litter has confirmed buildup of phosphorus and copper in soils and deep leaching of nitrate.

Four innovative technology farms have been selected to install and monitor new technology related to water quality, soil conservation, energy efficiency, and business management.

Watershed or Ambient Monitoring: The project has significant water quality monitoring activities. There is an extensive background surface water quality data base, including data from a joint USGS and Tennessee Valley Authority (TVA) station on Town Creek from the 1970's and data from a water quality survey in 1986. This data base, however, still needs to be fully compiled to be most useful.

The Alabama Department of Environmental Management (ADEM) has been monitoring six tributaries since 1988. Monthly grab samples are analyzed for physical parameters, dissolved oxygen, sediment, nitrogen, phosphorus, bacteria, and BOD. Biomonitoring is to be conducted at 4-6 of these sites. Data indicate that stormflows represent the most critical water quality problems and ADEM plans to expand the program to include storm event sampling.

The TVA is conducting water quality modeling of Town Creek Bay on Lake Guntersville, modeling seasonal patterns of temperature, oxygen, sediment, nutrients, and algae. The study has thus far used 1988 water quality data to calibrate the model and has begun to explore bay responses to potential management activities. Early model results indicated that animal waste controls are likely to be more cost-effective than sediment controls in improving water quality in the bay. It is anticipated that the model will be used to assess water quality response to changes in loadings from the HUA.

The US Environmental Protection Agency (EPA) is using the algal growth potential test (AGPT) as a means to measure algal growth response to actual water nutrient chemistry.

Biomonitoring is being conducted by TVA (fisheries) and EPA (benthic invertebrates). Fisheries surveys using the IBI method have documented the status of fish communities in several tributaries. It has been recommended that these surveys be repeated after Best Management Practice (BMP) implementation has been completed. Sampling of benthic invertebrates in 1988 and 1989 did not clearly indicate degradation and has been discontinued in favor of the AGPT described above.

Agricultural Management Monitoring: No intensive system has been set up to monitor BMP adoption. Tracking of land treatments and management is currently based on contracting records filed at contract completion and on annual status review of long-term agreements (LTA) and maintenance agreements. Only basic records are kept using CAMPS and a spreadsheet. Specifics on nutrient management plans are not being recorded.

A TVA aerial land use/nonpoint source inventory may be useful as a baseline for comparison with future land treatments. Low altitude color infraredR photography was used to inventory land use and animal waste sites. Soil loss was calculated for individual fields and sites for all agricultural land and the density of animal waste sites was recorded. Additional baseline information on animal waste utilization, fertilizer use, and crop rotations is available from a 1986-87 TVA survey.

Modeling: This project is currently using a Geographical Information System (GIS) in one sub-watershed in order to use the Agricultural NonPoint Source (AGNPS) basin-scale model. AGNPS evaluates single storm events (before and after treatment comparisons). Staff have also discussed using the Chemicals, Runoff, Erosion from Agricultural Management Systems (CREAMS) field-scale model to evaluate practices under 12 to 15 representative scenarios. Staff have a working knowledge of AGNPS and CREAMS but additional CREAMS training is being considered. Because the agricultural soils within the project area have significant leaching potential and because AGNPS and CREAMS only address surface losses, models that address leaching may need to be considered.

Project coordinators are *William R. Thompson (SCS/Auburn AL) and Jesse La Prade (CES/Auburn University).*

Upper Tippecanoe River Watershed HUA, Indiana

Abstract: This HUA is an area of interconnected lakes and impoundments and a shallow, vulnerable aquifer. Livestock and poultry production predominate in this heavily agricultural and highly erosive watershed. Surface water bodies suffer from sedimentation and eutrophication; groundwater is threatened by nitrates and pesticides. The focus of the HUA is application of pest, livestock, and nutrient management plans and erosion control on critically eroding cropland. Evaluation of project impact on water quality will be difficult due to the lack of extensive land treatment monitoring and the uncertain future of water quality monitoring.

Introduction: This 209,000 acre project in northeastern Indiana is underlain by outwash deposits of sand and gravel, which form the principal aquifer along the Tippecanoe River. High well yields, high permeability, and shallow water tables are characteristic of the area. There are 217 natural lakes and impoundments in the area with a total surface area of 6,600 acres.

About 75% of the watershed is devoted to agriculture, dominated by livestock and poultry, and their products. The main crops are corn, soybeans, wheat, and hay.

One-third of the watershed is designated a major erosion problem area. Sediment and associated nutrients from eroding cropland are significant contributors to lake eutrophication. Four major drainage areas within the HUA have been identified as having critical water quality problems derived from agricultural nonpoint sources.

Pesticide leaching and runoff potentials are considered high for one-half and one-fourth, respectively, of the HUA's soils. The one-third of the watershed identified as a Major Erosion Problem Area produces 11 tons/acre/year of sheet and rill erosion. Corn and soybeans account for about 60 percent of cultivated cropland. Tillage is 80 percent conventional. Fertilizer is normally broadcast in fall or spring before planting. Nearly all animal waste (swine and poultry) is broadcast spread. Because most facilities have a 90-day or less storage capacity, manure is spread 2-3 times annually, often on the same fields. Rates of 10-20 tons/acre are common.

Groundwater quality is also a concern. Sampling of private water supply wells from 1984 through 1987 showed that 40% to 55% of the wells contained nitrate levels exceeding 10 mg/l.

Project objectives are to reduce the potential for nitrate and pesticide contamination of groundwater, reduce the potential for phosphorus contamination of surface waters, and reduce the potential for sediment pollution to streams and lakes. Land treatment will focus on pest, livestock, and nutrient management plans and on erosion controls on critically eroding cropland.

Site Level Monitoring: Just one demonstration site is being monitored for water quality, a ditch which originally drained an untreated feedlot directly into Tippecanoe Lake. The project hopes to do additional edge-of-field monitoring associated with these demonstration farms in the future.

Watershed of Ambient Monitoring: The County Health Department is sampling surface water in six subwatersheds four times a year pre- and post-planting and pre- and post-harvest. Samples have been analyzed for nutrients, bacteria, and pesticides. The County Health Department also has some baseline data from a nitrate survey of domestic wells.

The Indiana Department of Environmental Management (IDEM) began a groundwater quality survey in 1990, sampling 30 wells in the southwest project area for nitrates, pesticides, and VOCs. Data from 1990 are considered to be unreliable due to quality assurance/quality control (QA/QC) problems. The survey was to be repeated in 1991, with three samplings (pre-plant, growing season, and post-harvest).

A "before" lake water quality assessment of 24 lakes was conducted in 1988-89 under the sponsorship of the Kosciusko Lake Preservation and Development Council and the Indiana Lake Enhancement Program. While these assessments were valuable in documenting impacts of sedimentation and eutrophication in many of the lakes and helped to identify agricultural nonpoint problem areas, their value as baseline data is uncertain. There are currently no plans to continue or repeat this work.

Agricultural Management Monitoring: The main basis for tracking adoption of improved management practices is recording of numbers of participating farms and acres adopting nutrient, pesticide, and sediment management practices.

A survey to develop an initial data base of production and management practices, including fertilizer and pesticide use, soil tests, tillage, etc., has not yet been completed. Thus far, response has been just 32%. Another survey is planned at the end of the project to assess changes in production practices. A GIS effort focused on land treatment tracking originally called for in the work plan has not been funded.

Modeling: Project staff plan to use the CREAMS, Groundwater Effects of Agricultural Management Systems (GLEAMS), Nitrogen Leaching and Economic Analysis Package (NLEAP), Erosion Productivity Calculator (EPIC) and/or Eutrophication Model (EUTROMOD) models to evaluate the on-site effects of land treatments on the demonstration farms. In addition, project staff participated in EPIC/SWRRBWQ training in February 1992.

SWRRBWQ is the Simulator for Water Resources in Rural River Basins: Water Quality. The first application of a field-scale model will be to investigate the applicability of EPIC by building representative EPIC data sets and simulating effects that Conservation Reserve Program sign-ups may have on water quality. Plans also involve using a GIS linked to the AGNPS basin-scale model to aggregate single storm events over the project area.

Project coordinators are *Max Evans (SCS/Indianapolis IN) and Sarah Brichford (CES/Purdue University).*

Sycamore Creek Watershed HUA, Michigan

Abstract: Agriculture in this south-central Michigan watershed is primarily livestock based, with significant cropland acreage. Surface waters are impaired by sediment, nutrients, and pesticides. Land treatment focuses on erosion control and ICM. A strong monitoring program, including fertilizer and pesticide input tracking on 20 demonstration farms and a paired watershed study of surface water quality response to the land treatment program, offers strong opportunity to assess actual project impact on water quality.

Introduction: This project includes some 68,000 acres of primarily agricultural land in south-central Michigan, plus parts of the cities of Holt and Lansing. Agriculture is predominantly livestock based, including dairy, hogs, and beef. Sources of nonpoint source pollutants include severe cropland erosion and over-application of fertilizers and pesticides. Corn, soybeans, and wheat are the principal crops cultivated. Tillage is primarily conventional.

Water quality is significantly affected by sedimentation and oxygen depletion, which impair the suitability of the stream for recreation and for fish habitat. Violations of Michigan water quality standards for dissolved oxygen have been recorded in Sycamore Creek. High nutrient concentrations contribute to eutrophication and threaten groundwater quality.

Project goals are directed toward identification of significant agricultural nonpoint sources and promotion of conservation practices that significantly reduce sediment, nutrient, and pesticide loading to surface waters. Specific objectives for land treatment include reduction of edge of field sediment delivery by 50% and reduction of nutrient and agrichemical use by 20%. Conservation plans will focus on BMPs for cropland erosion control, ICM, and pest management.

Site Level Monitoring: There are currently just two demonstration activities both focusing on nutrient management but not emphasizing water quality monitoring. Field-level fertilizer and pesticide inputs are being monitored on 20 watershed farms. Data on nutrient and other chemical inputs are reported through a crop management association. Replicated demonstration plots have been set up on three farms for spring nitrate testing to measure residual soil nitrogen and to help adjust nitrogen fertilizer applications.

Watershed or Ambient Monitoring: The Michigan Department of Natural Resources (MDNR) is monitoring three small watersheds in a paired watershed design, with two watersheds undergoing land treatment and the third (outside the HUA) serving as a control. The treatments include no-till, cover cropping, ICM, and bank stabilization. Spring runoff events are sampled at automated stations for sediment, nutrients, and COD. MDNR has collected 2 years of calibration data; sampling will resume after implementation of BMPs in the treatment watersheds is complete.

MDNR has completed an assessment of stream biological communities in Sycamore Creek, including examination of plants, invertebrates, and fish. MDNR is also modeling parts of the Sycamore Creek with AGNPS and will use monitoring data to validate the model. MDNR has some limited urban stormwater monitoring in parts of Holt and Lansing.

The Ingham County Health Department has conducted some groundwater flow and quality assessment in the shallow drift aquifer which underlies the project area. The Department located 18 test wells at 12 sites down the length of the watershed and conducted sampling for nitrate, metals, herbicides, and pesticides. An assessment of aquifer vulnerability based on soils and land use was also conducted in the watershed.

USGS is conducting some limited groundwater herbicide screening as part of a larger effort in the Grand River Watershed. Pre- and post-application storm events are being sampled in three small watersheds for three pesticide groups: triazines, alachlor, and 2,4-D. Two events will be monitored at each site, with six samples collected over the course of the event.

Agricultural Management Monitoring: There is considerable land treatment monitoring in the HUA. Extension is tracking ICM, Integrated Pest Management (IPM), and fertilizer management activities through the crop management association created for the project. For the 20 cooperating producers, management activities are being tracked field by field; inputs will be compared with and without BMPs.

SCS is conducting numerous land use and agricultural activity monitoring. The Universal Soil Loss Equation (USLE) is being used to estimate quantities of soil saved, requiring the collection of data on total numbers of farms participating, practices implemented, and acres treated. USLE will be run in before-and after-scenarios.

SCS is also using CAMPS to record conservation plan records and the Geographic Resources Analysis Support System (GRASS) to maintain land use information in the HUA. Field boundaries and soil classification by pesticide leaching potential are being digitized.

Modeling: The project staff is using National Pesticide/Soils Database and User Decision Support System for Risk Assessment of Ground and Surface Water Contamination (NPURG) to prioritize the soils/pesticide combinations for pesticide leaching and runoff potentials. They plan to use the EPIC and EUTROMOD models at the field scale to predict before-and-after effects of systems of practices on pesticide, sediment and nutrient loadings. Staff participated in an EPIC/SWRRBWQ workshop in February 1992. Staff will use field data from some 20 demonstration farms for very detailed field-scale model verification for specific ecosystems. Wind erosion may be assessed with the EPIC model. Staff also plan to use AGNPS to aggregate the nitrogen surface losses to the project/watershed level. The MDNR is already using AGNPS. The land treatment data will be tracked using the GRASS GIS which is already linked directly to the AGNPS model.

Project coordinators are *Shirley Gammon (SCS/East Lansing MI) and Mark Hansen (CES/Michigan State University).*

East Sidney Lake Watershed HUA, New York

Abstract: East Sidney Lake is a highly eutrophic flood-control reservoir that is also used for recreation. Lake water quality is impaired due to sediment, nutrients, and oxygen-demanding substances. The main agricultural nonpoint sources are: barnyard runoff, overgrazing, poor manure management, improper manure storage, and livestock in streams. Principal pollutants are phosphorus and sediment. Management practices being implemented include waste management systems, ICM, planned grazing systems, and cropland erosion control. Because of budgetary shortfalls in the State Department of Environmental Conservation (DEC), most water quality monitoring efforts called for in the original plan have not been undertaken. Efforts are being made to collect as much detailed agricultural management data as possible, and evaluation of project impacts on water quality will most likely be based on computer simulations.

Introduction: East Sidney Lake is a reservoir created in 1950 for flood control and subsequently opened for recreation. Significant groundwater resources occur only in the floodplain soils of Ouleout Creek. East Sidney Lake has been highly eutrophic since its inception. Lake water quality is impaired for swimming and stressed for aesthetics as a result of sediment, nutrients, and oxygen-demanding substances from the watershed. Oxygen depletion in the deeper lake waters is a common problem, and at least one fish kill has occurred. In some areas, private wells have been contaminated with nitrate and bacteria. Residents and the New York State Department of Health have attributed this to manure spreading from dairy operations, although in these areas most dairy farms have recently gone out of business.

There are 138 agricultural operations in the 70,800 acre watershed. Corn and hay are the principal crops grown, primarily in support of the 52 dairy operations in the watershed. Tillage is conventional. Nutrient application methods are generally those to maximize crop production for livestock operations. Because storage facilities are very limited, animal waste is normally spread daily except in the winter, when it is stacked on the ground. Baseline nutrient application rates are not generally known. Demonstration studies of farm nutrient input/output budgets are underway on five pilot farms. The primary agricultural nonpoint sources in the HUA are: barnyard runoff, overgrazing, poor manure management, improper manure storage, and livestock in streams. Principal pollutants are phosphorus from improper management of agricultural wastes and sediment from excessive cropland erosion, as well as microorganisms such as *giardia lamblia*.

The principal objectives of the project are to characterize nonpoint source/water quality relationships in the Ouleout Creek watershed and to specify and implement effective nonpoint controls and in-lake remedial measures to meet designated use goals. The management practices being implemented include waste management systems, ICM, planned grazing systems, and cropland erosion control.

Site Level Monitoring: Demonstration studies of farm nutrient (N and P) input/output budgets are being carried out on five pilot farms in the HUA. Specific losses in runoff, leaching, etc. are not being measured. Five single field demonstrations are being conducted to calibrate a nitrate soil test to assist in overall nitrogen management planning. Both demonstration activities focus on soil fertility, rather than water quality concerns. The original plan for the project called for some water quality monitoring of demonstration sites to measure practice effectiveness, but to date none has been funded.

Watershed or Ambient Monitoring: CES has conducted a synoptic survey of water quality and land use in the Ouleout Creek watershed to identify subwatersheds likely to be affected by agricultural runoff. This effort was subsequently focused on the Treadwell Creek subwatershed as a particular problem area. Again, the effort was a synoptic survey intended to assess the influence of agriculture on water quality. These studies have been completed and are not scheduled to be repeated.

The original project proposal called for NY DEC to conduct a paired watershed study in the HUA to evaluate the impacts of land treatment on water quality. However this effort was not carried out because of inadequate State funding.

In summer of 1990, the New York Department of Natural Resources (DNR) evaluated biological indicators at 12 stations on selected tributaries. At the same stations, Cornell University took biweekly samples for temperature, conductivity, pH, and phosphorus.

Cornell University also sampled wells in the watershed for bacteria and nitrates to evaluate the effects of septic systems and, to some degree, agricultural influences.

The U.S. Army Corps of Engineers (Corps) is attempting an in-lake remediation project through hypolimnetic aeration. As background to this effort, the Corps conducted a comprehensive study of the lake and watershed, including collection of additional water quality data, an inventory of land use patterns in the watershed, and computer modeling of the reservoir. Results of this study provide a data base for East Sidney Lake water quality that may be useful in further reservoir modeling. The Corps is continuing to collect regular grab samples at the lake inlet, several lake stations, and at the outlet of the dam to evaluate the performance of the remediation effort.

Agricultural Management Monitoring: A preliminary evaluation and inventory of agricultural and other nonpoint sources in the watershed was conducted as part of the synoptic surveys mentioned earlier. SCS is tracking management practice implementation in the watershed, including such information as number of farms with contracts, number of barnyards treated, tons of soil saved, acres under ICM, etc. Although limited by severe budget shortfalls, SCS staff are also attempting to collect as much information as possible on specific management activities such as soil tests, manure tests, fertilizer use, spreader calibration, etc. as part of other ongoing programs.

Cornell University researchers are using the Generalized Watershed Loading Function (GWLF) for project evaluation. In the process of using this model, field-by-field baseline data are being collected, including soils, slopes, crops, animal populations, and locations of septic systems. SCS staff are also collecting detailed nutrient management data on 10 farms just outside the East Sidney Lake watershed.

Modeling: This project plans to use simulation models NPURG, Barnyard Runoff (BARNY), and GWLF) to rank vulnerable soil/ecosystems and Agricultural Manure (AGMAN) and EPIC to predict field-scale loading changes. These field-scale models can be coupled with the demonstration farms, especially in estimating nitrogen losses and that portion remaining in the soil. The nutrient balance work in the project is important to models, and water quality monitoring would complete the balance. The project staff has experience with AGMAN, NPURG, and GWLF. The plans do not address modeling off-site or watershed-scale effects.

Project coordinators are *Anthony J. Esser (SCS/Syracuse, NY) and Mark J. Walker (CES/Cornell University).*

Little Bear River HUA, Utah

Abstract: This project is directed toward reducing sediment and nutrient loading to rivers and reservoirs from rangeland and irrigated cropland. Land treatments will focus on stream channel and riparian zone improvements, improved rangeland and cropland management, and animal waste management. There is no intensive site monitoring, but there is a monitoring network to provide information on ambient water quality in the watershed. The ability of this ambient network to detect changes in water quality associated with land treatment, however, is limited, particularly in the absence of detailed land treatment tracking.

Introduction: Agriculture within the 197,000-acre project is devoted primarily to livestock feed production, grazing, and wildlife. Predominant land uses are rangeland (70%),

irrigated cropland (20%), and dry cropland (5%). Major crops are small grains and alfalfa. Tillage systems are conventional. Very few waste storage facilities exist; manure is spread all year long except during the winter when it is stacked on the ground. Application rates vary from 2 to 20 ton/acre. Little manure is incorporated into the soil when crop planting begins.

The Little Bear River watershed is a major source of sediment, nutrients, and bacteria to Hyrum and Cutler Reservoirs, and to the Bear River. Pollutants and their sources include: sediment from streambank and channel erosion; nutrients and coliform bacteria from pasture, cropland, and feedlots; irrigation return flows; and phosphorus from rangeland during spring runoff. Currently known water quality problems are mainly related to surface water.

The Little Bear River has shown violations of Utah water quality standards since 1984/1985 for phosphorus, nitrogen, BOD, dissolved oxygen (DO), and bacteria. Poor water quality due to eutrophication has impaired fisheries and recreational values in Hyrum and Cutler reservoirs.

Project goals are to improve water quality in the Little Bear River system by reducing nonpoint source water pollution. Land treatments will focus on bank stabilization, riparian zone filter strips, grazing management, animal waste management, pesticide management, cropland improvement, and improved irrigation water management.

Site Level Monitoring: Bank stability and sediment inputs at three sites are currently being monitored by Utah State University.

Watershed or Ambient Monitoring: The Utah Department of Environmental Quality (DEQ), the Bear River Health Department, and Ecosystems Research Institute have engaged in surface water monitoring in the Little Bear River watershed. The monitoring program at eight stations consists of monthly to semi-monthly grab samples analyzed for sediment, phosphorus, nitrogen, BOD, bacteria and streamflow. No storm event sampling was conducted, but future event sampling is planned. Some biomonitoring has also been conducted, including evaluation of species diversity indices.

Agricultural Management Monitoring: There is no system in place to monitor the extent of BMP adoption beyond standard SCS recording in CAMPS. The model AGNPS will be used as a quasi-GIS data base to help track land use in the project area. All cropland is currently entered into AGNPS in 40-acre grid cells, representing present conditions. Numerous land use parameters are being input to GRASS, including field boundaries, hydrology, roads, and land use, and links between CAMPS and GRASS are currently under development.

Stream channel and riparian zone management practices will be tracked using low-level video photography and the GIS. At present, this method, which includes an infrared band, is being used to identify channel areas needing improvement (e.g., eroding banks, gravel bars) and to help select sites for monitoring. On selected sites, permanent cross-sections will be established to monitor changes in channel and bank configuration over time and transects will be established up and downstream to assess long-term changes in vegetation. This approach will be useful in tracking response to both channel work and upland treatments such as livestock fencing.

Modeling: This project has used the DRASTIC ranking tool to rank pollution potential. Plans are to address field-scale or on-site nonpoint source sediment and nutrient questions with the EPIC and Pacific Southwest InterAgency Committee (PSIAC) models. PSIAC is specifically designed for rangeland. Project staff will be obtaining advanced EPIC training in January 1992. AGNPS will be used to aggregate up to the project/watershed scale. Land treatment data is being kept in GRASS GIS which is linked directly to the AGNPS.

Project coordinators are *Mark M. Petersen (SCS/Salt Lake City, UT) and Richard C. Peralta (CES/Utah State University).*

Monocacy River Watershed Demonstration Project, Maryland

Abstract: This project is directed toward reducing loadings of sediment, nutrients, and other agricultural chemicals to surface and groundwaters. Land treatments focus on improved nutrient, crop, and pesticide management in this predominantly livestock-based agricultural watershed. While there is little intensive demonstration site water quality monitoring, there is considerable ambient surface water monitoring. Data from these monitoring efforts and from detailed tracking of changes in agrichemical management should be a good basis for assessing change. Because of numerous other water quality efforts taking place in the watershed, isolation of changes specifically due to the project alone however will probably not be possible.

Introduction: Over 65% of this central Maryland watershed is in agricultural use, primarily cropland. There are some 3,500 farms in the watershed; livestock operations dominate, including dairy, poultry, and hogs. The project

area focuses on three sub-basins: Israel Creek, Linganore Creek, and Piney/Alloway Creeks.

Surface waters are listed as impaired for aesthetics, recreation, fisheries, and commercial uses by nonpoint sources. Principal pollutants are sediment and nutrients from fertilizers and animal wastes. Groundwater in shallow limestone aquifers is threatened by pesticides and nitrates from agricultural chemicals and fertilizers.

The goal of the project is to encourage accelerated adoption of management practices that will reduce loading of sediment, nutrients, and agrichemicals to surface and ground waters. Conservation practices focus on erosion and sediment control, conservation cropping, cover crops, and ICM: nutrient budgeting, manure storage, manure testing, pest scouting, and the use of cover crops for both nutrient management and erosion control.

Site Level Monitoring: There is little water quality monitoring associated with demo sites. Evaluation of demonstration sites will be based on monitoring of changes in quantity and timing of chemical inputs.

Watershed or Ambient Monitoring: The Demonstration Project is only the most recent land treatment/water quality project to be established in the Monocacy River watershed. There has been a complex array of programs and monitoring, partially evolving from the Chesapeake Bay program and the fact that 98% of Maryland - including the Monocacy - drains to the Bay. One result is the existence of background water quality data on surface water and groundwater.

The Double-Pipe Creek RCWP project has operated in a portion of the watershed since 1982, with the Maryland DNR conducting water quality monitoring. This project has been completed.

Land treatment in parts of the Monocacy watershed has been supported by the Maryland Agricultural Cost-share program (MACS) and the designation of the Piney/Alloway Creeks sub-basin as a Special Water Quality Project area by USDA.

In 1989, the Linganore Creek watershed was selected as the site of a USDA PL-566 Land Treatment project.

The most extensive project currently in operation in the Monocacy watershed is Maryland's Living Resources Targeted Watershed Program. The program includes implementation of conservation practices, cleanup of non-agricultural pollution sources, and extensive water quality monitoring. Under this effort an extensive baseline assessment is being carried out on six stations on Piney and Alloway Creeks. This assessment consists of monthly sampling for stream chemistry (including nutrients, bacteria, and physical parameters), stormwater sampling at a USGS gage, and synoptic testing. Benthic invertebrates are being assessed by the EPA Rapid Bioassessment Protocol, and fish communities are being evaluated by the Index of Biotic Integrity.

In its National Water Quality Assessment (NAWQA) program, USGS has assessed baseline streamflow, major ions, nutrients, bacteria, triazine pesticides, and benthic invertebrates in four subbasins. The focus of the effort will be examination of nitrate-nitrogen/algal growth relationships and on additional pesticide sampling.

A recent proposal submitted under EPA's Region III Section 319 regional set-aside program would add another monitoring effort in the Demo area. The proposal would essentially validate a model (based on CREAMS) to be used in targeting BMP implementation and refining monitoring efforts.

Agricultural Management Monitoring: Adoption of improved agricultural management practices in the project area is being monitored. Land treatment tracking is based on following progress on three main elements: number of farmers participating (e.g., conservation plans completed, cost-share participation), number of practices implemented (primarily tracked through CAMPS), and changes in nutrient use and other agrichemical inputs. Project staff are working directly with demonstration farms, while management on other farms is tracked by county SCS offices. Detailed recording systems are in development and extensive baseline data are being collected. This effort includes a data base on current fertilizer management and cropping system practices, detailed nutrient management records, and pesticide use data through IPM records.

Modeling: This project is addressing on-site, field-scale questions with the EPIC model which will complement off-site water quality monitoring. Twenty detailed farm management plans can be modelled over the long term and with varying weather to give a relative comparison of before-and-after conditions independent of outside influences. Basic EPIC training was completed in FY 1991. Project staff are involved in a major modification of CREAMS to aggregate its technology to a basin-scale.

Project coordinators are *Jeffrey R. Loser (SCS/Annapolis, MD) and Richard Weismiller (CES/University of MD).*

Herrings Marsh Run Demonstration Project, North Carolina

Abstract: This project is in a region of intense agricultural land use where both surface water and groundwater quality has been impaired by nutrients, sediment, and pesticides from hog and poultry production and from cropland. Land treatments will focus on animal waste management, nutrient management, and dead poultry composting. A combination of intensive site monitoring and extensive surface water quality monitoring designed in support of the project provides an excellent opportunity to document the effects of the project on water quality.

Introduction: This 5,100-acre project is in southeastern North Carolina. Soils are medium to coarse and are subject to seasonally high water tables. Surface waters have been designated as "support threatened" by the State water quality plan because of BOD, nutrient, and sediment inputs from agricultural nonpoint sources. Groundwater quality is also impaired by nitrogen and pesticides.

The project is marked by intensive agricultural activity, including major poultry and swine operations. In terms of acreage, major crops are corn, soybeans, vegetables, tobacco, and cotton. Tillage is largely conventional. Erosion is not a problem. Nutrient and pesticide application rates and methods are based on tradition and rule-of-thumb, with excessive fertilizer application in relation to nutrients applied in animal manure. More than 50 different pesticides are in use. Animal waste lagoons are typically undersized and subject to overflow. There is little or no erosion control. Over 75% of gross agricultural revenues come from poultry and swine production. The county ranks first in turkey production among all counties in the nation.

Nutrients, particularly nitrogen, are the primary nonpoint source pollutants. Animal manure provides more than half of the nitrogen needed for crop production, yet 90% of crop nutrients are purchased in the form of mineral fertilizers. Dead poultry disposal is also a major concern.

The overall goal is to eliminate the "support threatened" classification for Herrings Marsh Run. Major practices to be implemented include nutrient management, residue management, structural erosion control practices, and dead bird composting facilities. Water quality improvement goals include reductions of sediment inputs to surface waters by 50% and reduction of stream nitrogen concentrations from 13 to 4 mg/l.

Site Level Monitoring: Demonstration management practices include poultry litter application, intensive grazing, continuous corn production, land application of swine waste, and dead poultry composting. Water quality impacts at these demonstration sites will be monitored by ARS. Most monitoring will focus on groundwater effects in the shallow aquifer; monthly samples from water table observation wells will be tested for nitrate, other nutrients, and atrazine.

Watershed or Ambient Monitoring: Ambient water quality monitoring in the project area is substantial. ARS began sampling at five automated surface water stations within the project area in 1990. One of the stations monitors a control watershed where little or no land treatment is expected. Streamflow at each of the sites is monitored by USGS. Three samples are collected daily for analysis for nitrogen and phosphorus parameters.

The North Carolina Department of Environmental Management (DEM) has also agreed to conduct biomonitoring at three of the sites, including the control site. Annual kick seine samples of benthic invertebrates will be collected and evaluated for several diversity indices, including EPT.

Some 250 domestic and farm wells have been and will continue to be sampled for conductivity, nitrates, and pesticides.

Agricultural Management Monitoring: Monitoring of BMP adoption and management is a key effort. All SCS practices and some CES activities are being recorded in CAMPS, with other records maintained on spreadsheets. CES is primarily responsible for tracking pest management activities.

Project personnel are developing a system to document changes in nutrient and pesticide applications in the project area. One method of data collection will be an annual survey of all producers in the project area for detailed information on their nutrient, crop, and pest management activities.

Modeling: This project plans to use simulation models and a GIS to locate the soils with the greatest potential for NPS pollution problems. This will include modifying the Goss pesticide leaching/surface loss ranking tool. They will also analyze on-site before-and-after simulated relative comparisons of demonstration sites (using EPIC and Chemical Movement in Layered Soils -- CMLS), and track the adoption of new land treatment systems. The combination of monitoring and modeling seems well planned and adequate to evaluate the effects of changing land treatments. The one area that might need some additional work is the basin-scale aggregation of individual fields. With complete GIS data, the AGNPS model would

address a single event and could be linked directly to the GRASS GIS.

Project coordinators are *Maurice Cook (CES/No. Carolina State University) and Roger Hansard (SCS/Raleigh NC).*

East River Watershed Demonstration Project, Wisconsin

Abstract: This project focuses on reducing sediment and nutrient loads to surface waters and on reducing shallow groundwater contamination by nutrients, pesticides, and other agricultural chemicals. Management components to be demonstrated include improved nutrient and pesticide management on cropland and at the farmstead. Groundwater and surface water quality will be monitored on several sites, including a subwatershed targeted for intensive implementation. Ability to extend demonstration site assessment over the project area depends on the effectiveness of land treatment tracking, especially nutrient management records.

A State nonpoint source abatement program is beginning in the same area which includes more intensive land treatment and a more extensive monitoring program. While this monitoring program will provide a vastly improved data base for assessment, it is likely to be effectively impossible to distinguish between the impacts of the two concurrent programs.

Introduction: Nutrients, pesticides, and toxics from agriculture are contributing to groundwater and surface water contamination in the 141,000-acre East River watershed and to Green Bay of Lake Michigan. Nearly a quarter of the watershed lies in metropolitan Green Bay. Agriculture is dominated by the presence of 400 dairy operations with some 42,000 animal units. Major crop rotations are 2 years of corn, followed by small grains, and 2-4 years of hay. Tillage is 82 percent conventional. Most farmers have only a minimal manure management program, apply excessive amounts of nitrogen and phosphorus, and do not scout for pests. A typical phosphorus application rate is 120 lbs/acre, of which 30 percent is from fertilizer and 70 percent from manure. A typical nitrogen application is 220 lbs/acre, of which 25 percent is from fertilizer, 40 percent from manure, and the remainder from alfalfa. Inadequate crediting of livestock wastes for nutrient content is typical. Pesticide application methods and rates are extremely variable from producer to producer.

Major reaches of the East River flow over fractured limestone (karst) and rapidly recharge shallow aquifers used by the rural population. Some 30% of watershed soils have high groundwater pollution potential. High nitrate, pesticide, petroleum, and VOC levels have been documented in shallow private wells, and there is some evidence suggesting leakage to deeper regional aquifers.

Surface water problems are also important. Problems with excessive sediment, phosphorus, and toxics from agriculture have caused high turbidities, algae blooms, and fish consumption advisories. Since the project was initiated, priorities have shifted away from groundwater quality to phosphorus and sediment loading to Green Bay in surface waters.

The project will focus on cropland and farmstead management of nutrients and pesticides. About 70 farms in the Bower Creek subwatershed will receive intensive assistance; the remaining farmers in the watershed will be assisted through group planning and educational programs.

Site Level Monitoring: Six demonstration farms with complete resource management systems have been established, along with single practices installed on numerous other farms. Demonstration components include: nutrient management on corn and on forage (including soil testing and manure crediting), livestock waste management, pest management, stream corridor filter strips, barnyard and milkhouse waste management, and improvements in pesticide handling and application. In addition, a constructed wetland will be installed for milkhouse waste treatment.

Evaluation will emphasize documentation of changes in inputs, soil P levels, and nitrate concentration in the root zone. Groundwater monitoring will be conducted on demonstration sites, consisting of 25' and 50' wells sampled for pesticides, VOCs, nitrates, bacteria, and conductivity. In addition, water supply wells on all cooperating farms will be sampled for nitrate, chloride, bacteria, conductivity, and triazine herbicides at the start and at the end of the project.

Surface water quality monitoring on demonstration sites will consist of input/output monitoring of the wetland milkhouse waste treatment system and some edge-of-field monitoring.

Watershed or Ambient Monitoring: Wisconsin Department of Natural Resources (WDNR) operates a monitoring station on Bower Creek. The station is primarily event-driven using an automated sampler, supplemented by one or two integrated base flow grab samples each month. Samples are analyzed for sediment, phosphorus, nitrogen, and bacteria. Streamflow is recorded continuously by a USGS station.

The Green Bay Metropolitan Sewer District also conducts monitoring in the East River, Bower Creek, Baird Creek, and Mahon Creek, including streamflow, physical and chemical parameters, invertebrates, and habitat evaluation.

The most extensive monitoring effort in the area is likely to be associated with the State's East River Priority Watershed Program. The State's program overlaps the Demonstration project area, with the similar goal of reducing sediment and phosphorus loading to Green Bay. The program is expected to receive State funding soon in 1992.

Agricultural Management Monitoring: Monitoring management practice adoption relies mainly on conventional SCS farm planning procedures, USDA Agricultural Stabilization and Conservation Service (ASCS) records, and county SWCD records. Inputs such as fertilizer and manure applications will be tracked on some farms through local crop management associations. SCS has developed a nutrient budgeting worksheet that will be used extensively.

Some land treatment information will be tracked in concert with the use of the AGNPS model as a GIS system. Currently, baseline conditions for three small watersheds are entered into AGNPS. Ultimately, three scenarios will be run on these watersheds, comparing current conditions to 100% forested and to complete BMP implementation. he final means of tracking the adoption of land treatments in the project are will be a survey conducted before and after implementation.

Modeling: This project plans to use simulation models for quantifying the effects of land treatments at the field level (with EPIC, CREAMS, and GLEAMS) and at the basin-scale (with AGNPS). The project's GIS approach to land treatment tracking complements the data requirements for the AGNPS model which can be linked directly to GIS layers. Currently AGNPS has been run on three subwatersheds. AGNPS simulates only single storm events and tracks nutrients only on the surface (no rootzone leaching losses). Pesticide leaching/loss potential rankings suggest that leaching is also a concern in this watershed.

Project coordinators are *James Kaap (SCS/Madison WI) and Kevin Chelley (CES/Univ. of Wisconsin).*

Group II Projects: Primarily Ground Water, Nitrates, Pesticides, Irrigated Cropland

Inland Bays HUA, Delaware

Abstract: Agriculture supplies 35-55% of the annual nitrogen load to three major estuaries. The rapid growth of the poultry industry over the last decade has created problems for storage and utilization of poultry manure in the HUA. Heavy use of nitrogen fertilizers and spreading of poultry manure in excess of crop needs is the major source of nitrate loading to groundwater.

Low DO, high bacteria counts, and high nitrate levels all contribute to impairment of shellfishing and recreation in the Bays. Nitrate contamination of groundwater is serious, affecting not only the groundwater but also surface water problems due to the recharge of surface waters by groundwater.

Land treatments to be applied include nutrient management, dead poultry composting, water table control structures, IPM, and riparian zone protection.

There is no site-specific water quality monitoring associated with the land treatment efforts, nor is there extensive tracking of land treatments across the project area. Ongoing ambient monitoring efforts may contribute little to project impact assessment due to the complexities of the hydrologic system in the region.

Introduction: This 157,000-acre HUA includes three basins in southeast Delaware: Rehoboth Bay, Indian River Bay, and Little Assawoman Bay. Topography is very gently sloping. Dominant soils are sandy and well to excessively well drained. Most streamflow derives from groundwater; less than 10% of annual precipitation flows into the Bays as surface runoff. Over 75% of nutrient loads entering the Bays are believed to be transported in baseflow.

Agriculture is dominated by livestock production, particularly poultry, but also hog, beef, and dairy operations. Cropland, mainly corn and soybeans, occupies about 40% of the HUA. Major crops are soybeans, corn, and small grains. Two-thirds of corn acreage receives nearly 300 lb/ac of nitrogen. Atrazine, metholachlor, and alachlor are the primary pesticides used. The rapid growth of the poultry industry has created problems for storage and utilization of poultry manure produced in the HUA and for dead bird disposal.

Agriculture supplies 35-55% of the annual nitrogen load to the bays. Use of nitrogen fertilizers and spreading of poultry manure in excess of crop needs on sandy soils are the major sources of nitrate loading to groundwater. Other sources include concentrated animal housing and crop production.

All three Bays have excessive levels of nitrogen during most of the year. Low dissolved oxygen, high bacteria counts, and high nitrate levels all contribute to impairment of fish populations, shellfishing, and recreation in the Bays. Nitrate contamination of groundwater is serious; one third of all wells tested in the sandy coastal soils had nitrates exceeding drinking water limits. Contamination impairs both groundwater and surface water due to the major recharge of surface waters by groundwater.

The overall objective is to maintain and enhance the quality of water in the Inland Bays by reducing fertilizers, animal wastes, pesticides, and sediment entering the Bays from surface runoff, percolation and seepage. Land treatments will focus on nutrient management, dead poultry composting, water table control structures, IPM, and riparian zone protection.

Site Level Monitoring: There are no water quality monitoring demonstration sites presently operating in the HUA.

Watershed or Ambient Monitoring: There is considerable water quality monitoring and background data within the region. The Delaware Division of Public Health has collected 30 years of bacteria data (total coliform, fecal coliform, and enterococcus), primarily from stations in the Bays but also from some tributaries. The Delaware Geologic Survey sampled over 400 wells from 1987 to 1990 and documented nitrate contamination.

Other studies have confirmed that fertilizers and nutrients applied to agricultural land are the major sources of nitrate loading to groundwater. The distribution of nitrate in the unconfined aquifer underlying the HUA is influenced not only by land use but also by sediment and soil type and by complex regional and local groundwater flow patterns. The result is highly variable leaching of chemicals into the aquifer and great spatial variability in nitrate distribution. Complex flow paths may carry nitrates thousands of feet from their origin and deep into the aquifer where high concentrations may persist for decades.

DNREC has conducted 20 years of ambient water quality monitoring at over 40 stations in the area. Most stations are located in the Bays or in tidal areas; only a few are close to direct freshwater inputs to the bays. The data base includes monthly samples for nitrogen, phosphorus, chlorophyll, bacteria, BOD, and physical parameters.

DNREC has recently begun a study to compile existing data to assess trends and, by 1993, to develop a water quality monitoring plan and a comprehensive management plan for the estuary area.

DNREC also conducts some lake water quality assessments under the Section 314 Clean Lakes Program. These assessments consist of monthly growing season sampling for DO, pH, conductivity, secchi depth, and nutrients.

The Delaware Geologic Survey is conducting a study of nutrient loading to the Bays in groundwater as part of the Inland Bays Estuary Program.

The University of Delaware is examining the distribution of nutrients along salinity gradients from freshwater inlets into the Bays themselves.

Agricultural Management Monitoring: Plans for monitoring adoption of management practices across the HUA are unclear. Contracting and practice installation activities are being tracked through CAMPS, but this system will not provide information on actual management. Basic contracting information may be adequate for structural practices such as dead poultry composters, but not for nutrient management or animal waste management. CES keeps records of activities like spreader calibration and demonstrations of the N quick test, but cannot determine if producers are subsequently following the nutrient management plan. Similarly, detailed information is being collected on IPM demonstration acres, but not on acreage of other producers who adopt IPM.

Modeling: Project staff are using NLEAP to model field-scale, on-site water quality questions. This model looks at nitrogen fate and transport on a homogeneous field, but does not address pesticides or structures such as riparian zones which are included in several of the project's goals. The AGNPS single-event model is being considered for evaluating the project/watershed as a whole, but the hydrogeology of the area (interflow flowing to the bays with long travel time and existing NO3 pulse already in the system) does not match the capabilities of the model.

Project coordinators are *Paul Petrichinko (SCS/Dover, DE) and Tom Williams (CES/University of Delaware).*

Illinois River Sands HUA, Illinois

Abstract: This project is located on land with very well drained sandy soils underlain by an extensive shallow sand and gravel aquifer which is the main source of drinking water for local residents. The aquifer is vulnerable to contamination by agricultural chemicals from intensive irrigated cultivation of vegetable crops. The project focuses on reduction of nutrient and pesticide inputs to cropland by improving nutrient and pest management and on reduction of transport of these chemicals to the aquifer through improved irrigation management. Due to lack of intensive monitoring, project evaluation will involve documentation of improved practices and changes in chemical inputs.

Introduction: The 250,000-acre project area is level to moderately sloping with well drained sandy soils underlain by an extensive sand and gravel aquifer that lies just 3 to 12 feet below the surface. This shallow aquifer is the main source of drinking water for local residents.

Some 450 farms in the project area produce corn, soybeans, and specialty crops such as green beans and sweet corn. Center pivot irrigation is extensive. A few specialty crops require pesticide application every 3-4 days through the growing season.

Although actual impairment of the groundwater has not yet been documented, detection of high concentrations of nitrate and trace levels of pesticides in shallow groundwater in a 1986-87 survey sounded a warning of significant threats to drinking water quality.

Project goals are to maintain and enhance the quality and quantity of the shallow aquifer and to reduce wind erosion. The primary focus is on nutrient and pest management and improved irrigation management.

The principal practice to be applied is a cover crop on no-till, both to recapture excess N and to reduce wind erosion. Additionally, installation of check valves in irrigation lines is receiving much attention, since backflow from fertigation can contaminate groundwater directly.

Site Level Monitoring: Two research plot-studies are being carried out to assess nitrogen and herbicide movement in soil water under plots of different crop/cover/fertilization treatments. The results will be used to evaluate the potential of cover crops and residue treatments to reduce movement of soil-applied nitrogen and herbicides out of the root zone and into the shallow groundwater.

Watershed or Ambient Monitoring: There is essentially no additional monitoring being conducted in the project area. All State Geologic Survey resources have been allocated to a statewide ambient groundwater monitoring program which includes only three sites in the project area.

A county wellhead protection survey recently offered free nitrate and bacteria tests as an incentive for participation by local landowners. However, response has been very low.

Agricultural Management Monitoring: Monitoring adoption of improved management practices in the project area is minimal; however, project personnel are developing an increasing appreciation for the importance of tracking progress closely. Adoption of improved management practices is currently done only through ASCS records.

The canning companies have an important role in tracking nutrient and pesticide inputs in the area. Most of the specialty crops are produced under contract with a cannery, and individual farmers have very little control over chemical application to cropland. Since the specialty crop market is very competitive, canneries have been reluctant to release specific information concerning chemical inputs. Company fieldmen and researchers, however, have shown a growing interest in the water quality project and in cooperating with University of Illinois personnel to improve pesticide and fertilizer efficiency.

Modeling: The NLEAP, EPIC, and GLEAMS field-scale models are being considered. These models will simulate the lysimeter and coring scenarios which can serve to validate the nitrogen and pesticide fate and transport through the root zone. Irrigation scheduling and wind erosion can also be addressed using simulation models. Staff attended EPIC training in February 1992. Modeling groundwater flow and transport is much more complicated than a field-scale/bottom of root zone approach. A high water table and relatively rapid flow of groundwater complicate this hydrology even further.

Project coordinators are *Gary Parker (SCS/Champaign, IL) and George F. Czapar (CES/University of Illinois).*

Ontario HUA, Oregon

Abstract: The primary water quality problem in the 157,000 acre-HUA is contamination of a shallow sand and gravel aquifer with nitrates and pesticides from irrigated cropland. The project will promote accelerated adoption of improved nutrient and pesticide management. Demonstration site monitoring should help assess the effectiveness of the BMPs at the field scale and an area wide groundwater monitoring network should be able to detect trends in water quality. However, changes in

groundwater quality may be masked by nitrogen and pesticide loads already in the vadose zone. Lack of detailed management practice monitoring will make it difficult to tie changes in water quality to the land treatment program.

Introduction: Intensive irrigated agriculture is practiced in the semi-arid valleys of eastern Oregon. Major crops, in terms of acres cultivated, are wheat, sugar beets, onions, potatoes, dry beans, field corn, sweet corn, and mint. Ninety percent of the cropland is furrow irrigated; 200-400 lbs/acre of nitrogen application rates are common. Dacthal (used only on onions) is the only pesticide of concern. It is banded at 4 lbs a.i./acre and/or broadcast at 6-9 lbs a.i./acre. About half of the area's dairies have adequate waste facilities. Dairy pollution is not considered a major problem to be addressed by the HUA; it is addressed through a separate cost-share program.

Drinking water is impaired by high concentrations of nitrate nitrogen, with nitrate levels exceeding the health standard of 10 mg/l detected in 30% of wells tested. Sodium, arsenic, selenium, and lead (all of which occur naturally in the watershed) have been detected at concentrations exceeding Maximum Contaminant Levels (MCLs) in groundwater. Dacthal Di-acid (a metabolite of Dacthal, the most widely used pesticide in the area) has been detected in some groundwater samples, but well below critical health levels.

Irrigation and widespread fertilizer and pesticide use are believed to be the major contributors to groundwater quality problems. High levels of sediment and nutrients in surface waters result from furrow irrigation. The objectives of this project are to improve groundwater and surface water quality by reducing nitrogen application and pesticide use on irrigated cropland through demonstration and encouragement of improved fertilizer and pesticide management practices. Water quality goals are stated quantitatively and are tied to Oregon's state water quality standards.

Site Level Monitoring: Extensive monitoring of BMPs at the field level is being conducted at the Malheur Agricultural Experiment Station. Nitrogen fertilizer efficiency (i.e., rate and timing) is being evaluated, including nitrogen movement through the soil profile, losses from the root zone and nitrogen recovery with secondary crops. Other treatments being tested include irrigation water erosion (i.e. soil and nutrient losses in surface runoff from furrow irrigation) and use of straw mulch. In an additional study, the nitrogen content of irrigation ditch water is being tested to support fertilizer management.

Watershed or Ambient Monitoring: The Oregon Department of Environmental Quality (DEQ) has an extensive background data base for surface water and groundwater. The DEQ maintains an ambient monitoring network that includes six stations in the HUA where monthly samples are analyzed for COD, TOC, sediment, nutrients, bacteria, and major ions. DEQ's ambient groundwater monitoring program also operates in the HUA and includes 40 domestic wells sampled bimonthly and analyzed for nitrate and dacthal, with two samples/year for a complete inorganic and pesticide screen. This program is specifically designed for groundwater trend detection.

The Malheur County Soil and Water Conservation District and Oregon State University, along with SCS, are conducting a 1-year study of vadose zone contamination. Deep soil samples from sites selected to assess the vadose zone across major groundwater contamination zones are being collected and analyzed for nitrogen and dacthal.

A regional U.S. Department of Interior irrigation drainage reconnaissance study is also being conducted in this HUA and elsewhere to identify potential toxic water pollutant problems from agriculture in the western U.S. The reconnaissance was conducted in 1990 before, during, and after the irrigation season and focused on analyzing for trace elements and pesticides in water, sediment, and fish tissue, as well as on major ions and nutrients in water. Final results are expected to be released by the end of 1991.

Agricultural Management Monitoring: There is no intensive program in place for land treatment tracking in the HUA. Current plans for monitoring the progress of practice adoption and management emphasize record keeping based on water quality farm plans, with spot checks by local project personnel, and perhaps a producer survey. Given that the practices being applied are predominantly management-based rather than structural (e.g., fertilizer timing and rate), close tracking of actual management activities by producers is quite important. Project staff should devote additional effort to land treatment tracking.

Modeling: Vadose and groundwater zone effects from management practices may exceed the time frame of this project. Therefore, simulation models may provide the opportunity for long-term "what if" scenarios for relative comparison of before/after effects.

Furrow irrigation, which is central to this project, is very difficult to model. Irrigation scheduling and the distribution of water along furrows is being addressed by the FUSED, FURROW, and FIRI models. EPIC and NLEAP are being considered as field-scale models in addition to GLEAMS

which also addresses the effects of surface structures. Staff have experience with EPIC and GLEAMS.

On the basin-scale, the SWRRBWQ model is under consideration. SWRRBWQ looks at large percentages of the watershed rather than a field-by-field approach. Two additional models are being considered, Nitrogen-Tillage-Residue Management (NTRM) and CIRRUS.

Project coordinators are *Robert L. Hummel (SCS/Portland, OR) and Mike Howell (CES/Oregon State University).*

Lake Manatee Demonstration Project, Florida

Abstract: This project focuses on reducing nitrogen loading to Lake Manatee via groundwater draining from irrigated cropland. Demonstration sites present improved nutrient and irrigation water management practices. They are well monitored and should document the effectiveness of the improved management. It may be difficult to extrapolate such results over the watershed and simulation models may be relied on to assess project effectiveness.

Introduction: Lake Manatee provides drinking water for Bradenton on Florida's central Gulf Coast. The lake is highly eutrophic and algae blooms are common. Because the upper reaches of the lake's watershed lie in a phosphate mining region, phosphorus levels in lake water are very high (>200 ug/l) and the lake is considered to be nitrogen limited.

High levels of nitrate have been documented in shallow groundwater and drainage waters from traditionally-managed citrus and vegetable cropland. These elevated nitrate levels are thought to result from excessive application of nitrogen fertilizers (300 - 400 lbs per acre on vegetables is typical) and poor irrigation water management. Nitrates and pesticides are transported in shallow groundwater flow to the lake.

The goal of the 81,000-acre project is to encourage producers to adopt water, nutrient, and pesticide management practices to reduce contamination to shallow groundwater and to surface runoff that contributes to recharge of Lake Manatee.

Site Level Monitoring: Eight to ten sites on citrus and vegetable operations demonstrate new systems to minimize surface runoff and improved water accounting to reduce excessive water applications. Nutrient management practices include soil testing, adjustments in fertilizer quantity and timing, and double-cropping.

Networks of shallow groundwater observation wells and piezometers have been established in and around these fields, which include multi-level samplers capable of sampling shallow groundwater at 2-foot intervals. Samples are collected biweekly, with more frequent sampling planned to follow some fertilization or precipitation events. Periodic soil testing is planned to account for occurrences of high nitrate concentrations in groundwater and to assess N content of the vadose zone. Overall, the strategy is to estimate nitrate flux from the demonstration fields by tracking nitrate movement in the field, at the bottom of the root zone, and leaving the field.

Nitrate-nitrogen and ortho-phosphate are the only chemical parameters being evaluated. Funding was not available for pesticide analysis, although CMLS, a pesticide/soil vulnerability index, is being evaluated for some sites.

Watershed or Ambient Monitoring: Monitoring by the County Public Works Department consists of monthly grab samples and analysis for nutrients, chlorophyll, and algae cell counts.

The Public Works Department also operates a small demonstration project in an area which has demonstrated high nitrate levels(>50 mg/l) in tile drainage. Several improved management practices are being demonstrated and monitored: tailwater recovery, filter/buffer strips, and wetland/pond treatment.

Agricultural Management Monitoring: Installation and operation of irrigation, nutrient, and pest management on demonstration sites is being tracked in detail. Tracking adoption of Irrigation Management Practices (IMPs) by other growers in the Demonstration area is uncertain. On non-demonstration farms, practices are tracked by SCS only when installed and reported through the conventional SCS technical assistance procedures. If farmers are doing irrigation management without SCS assistance, for example, or installing systems that do not fully meet SCS standards, no information is available within a formalized system.

A system to track practice adoption is being developed in the project SWCD office using GRASS. The system, not yet in operation, will inventory irrigation, nutrient, and pest management activities in the watershed and map groundwater monitoring sites and N levels. Links to County ARC/INFO files on soils, land ownership boundaries, etc. are under study.

Modeling: This project is addressing the loss of nitrogen, phosphorus, and pesticides at the field-scale level with a strong combination of monitoring and modeling. The staff is using a University of Florida algorithm (developed by

Hornsby, Brown, and Hurt) to estimate leaching/loss potential ranking for soil/chemical combinations.

The field-scale models being applied include CMLS and EPIC, while Two-Dimensional Variably Saturated Ground-Water Flow (VS2D) and Heat and Solute Transport in 3 Dimensions (HST3D), two USGS models, are possibilities for looking at nutrient movements beyond the root zone to groundwater. Decisions on basin-scale modeling are not as clear cut. A GRASS GIS is planned. Manatee County officials are doing some land tracking work on an ARCINFO GIS. Linkages do exist for exchanging data between these two very different GIS packages.

Project coordinators are *Brian McNeal (CES/University of Florida) and Ken Murray (SCS/Gainesville, FL).*

Anoka Sand Plain Demonstration Project, Minnesota

Abstract: This project is characterized by sandy soils overlying a shallow aquifer where high fertilizer and pesticide use and cropland irrigation combine to give a high potential for aquifer contamination. Both nitrate and triazine herbicides have been detected in groundwater. Specific project objectives are to reduce loading of nitrogen and pesticides to the aquifer by improving management of fertilizer nitrogen and pesticide inputs and by increasing irrigation efficiency to reduce chemical leaching. Land treatment will emphasize areas in corn and potatoes and will focus on improved nutrient and pesticide management practices, including ICM. Fifty producers are targeted for intensive and comprehensive nutrient and pesticide demonstrations through specialized BMP consultants and forty additional producers will utilize ICM. Water quality monitoring on demonstration sites and through the Management Systems Evaluation Areas (MSEA) project will likely provide good data on impacts of individual practices on the vadose zone.

Introduction: This 243,000-acre, 11-county project is located in a region characterized by sandy soils that are low in organic matter and that overlie a shallow aquifer. Field corn, soybeans, potatoes, and sweet corn are grown under both irrigated and non-irrigated conditions. Dairy and poultry are the main livestock production activities. Portions of this area are dominated by irrigated cropland requiring high fertilizer and pesticide inputs; there is a high potential for contamination of the aquifer.

Some 60,000 acres are irrigated. Most producers apply nitrogen at planting or as a sidedress during the summer. Somewhat less than half use a nitrification inhibitor. Over four-fifths use herbicides, and half use crop rotations for weed control. Nearly three-fourths of irrigators either do not practice scheduling or use the "hand-feel" method. Animal waste management is an integral component of all nutrient management plans where producers apply animal waste to cropland fields. ICM is being demonstrated on 50 Tier I farms.

Nitrate concentrations exceeding 10 mg/l have been documented in 30% of wells tested, with the highest levels in areas of intense irrigated crop production. There is also an incidence of triazine herbicide detections in area groundwater. Because the Anoka aquifer is believed to recharge the Mississippi River and another Aquifer to the south, water quality problems in the project area may be a threat to the drinking water supply for Minneapolis-St. Paul.

The primary objective is to reduce loading of nitrogen and pesticides to the aquifer by managing nitrogen and pesticide inputs and by increasing irrigation efficiency to reduce chemical leaching. Cooperating producers will demonstrate best management practices on a variety of crops and may also use ASCS cost- sharing under SP-53, ICM. Land treatment will focus on areas in field corn and potatoes.

Site Level Monitoring: Monitoring in soil, plants, and the root zone is planned to begin on some of the 50 demonstration farms in the second year of the project. The monitoring design is as yet unspecified.

The most extensive site monitoring is being conducted under the MSEA program, a joint effort of the Minnesota Agricultural Experiment Station, ARS, and USGS. This program was specifically written to fit in the Anoka Sand Plain and will evaluate practices to be implemented in the demonstration project. These practices include irrigated corn/soybean rotation with ridge tillage and potato/sweet corn rotation. Both fertilizer (N) management and herbicide (atrazine, alachlor, metribuzin) management will be evaluated. Networks of observation wells on 4-5 acre plots will evaluate nitrogen and pesticide losses to groundwater.

Watershed or Ambient Monitoring: Some background information exists for the Anoka Sand Plain aquifer with the USGS, the Minnesota Geologic Survey, the Minnesota Pollution Control Agency, and the Minnesota Department of Agriculture.

MPCA has begun a monitoring program within the Demo area, focusing on the shallow groundwater system and the upper vadose zone. The goal is to select a few practices that have not been well documented (e.g., manure management) and assess chemical movement from the root zone to the top of the water table with temporarily installed mini-wells.

Agricultural Management Monitoring: Management activities on the 50 demonstration and 40 SP-53 farms will be well documented by BMP consultants and County staffs. In addition, standardized farm accounting systems employed for financial management will track fertilizer and chemical inputs.

Tracking BMP adoption beyond the 90 participating farms will be done less intensively. A baseline survey has been conducted to determine current fertilizer and pest management practices in the Demonstration area. This survey will be repeated at the end of the project to assess adoption of improved management practices.

Modeling: This Project is using models to address irrigation scheduling (WISP and SCHEDULER) and nutrient/pesticide questions at the field-scale (NLEAP, EPIC, GLEAMS, and a Minnesota-specific nitrogen transport model). These models address on-site questions. Simulation modeling to address other project objectives (off-site pollution of groundwater aquifers and basin-wide effects of land treatments) require other models.

Project coordinators are *Fred Bergsrud (CES/University of Minnesota) and Jon DeGroot (SCS/St. Paul, MN).*

Mid-Nebraska Water Quality Demonstration Project, Nebraska

Abstract: This 15-county project focuses on reducing nitrate and pesticide losses from irrigated corn production, thereby limiting contamination of the vadose zone, and ultimately of deep groundwater. While the improved management practices implemented on the demonstration fields may reduce chemical losses from the root zone, short-term changes in groundwater quality are unlikely due to the extremely slow movement of water through the vadose zone. Monitoring and evaluation, therefore, focus on vadose zone testing and on determining changes in nutrient and water inputs to the land. Assessment of total project impact will be difficult because of the very large project area (1.2 million acres) and the lack of detailed management data beyond the demonstration sites.

Introduction: Upland soils in this irrigated corn region of south-central Nebraska are generally medium to fine textured loess soils that overlie groundwater 100-300 feet deep. Typical nitrogen application on corn is 180 lbs/acre. Three-fourths of irrigation on the 33 demonstration farms is by furrow; the remainder by center pivots. About half of the cooperators apply nitrogen in the fall, regularly use crop consultants, and use banded herbicides.

Based on well testing, groundwater beneath these soils has recently shown trends of increasing nitrate and atrazine levels. High groundwater nitrate levels correspond to areas where irrigated corn is grown. While impairment of the deep aquifer has not been observed, continued deep percolation of excess irrigation water is expected to drive nitrates and possibly pesticides in the vadose zone downward into the aquifer.

The project goal is to foster the adoption of BMPs for irrigated corn production, focusing on irrigation water management and nutrient management.

Site Level Monitoring: Demonstration activities are taking place on 33 farms for improved irrigation management through irrigation scheduling, soil moisture testing, and improved equipment and for nutrient and pesticide management through soil testing, nutrient crediting, and delayed application of nitrogen fertilizer. Each site has had four 30' deep soil cores drilled to characterize nitrate levels in the vadose zone. Fourteen fields are being tested to assess nitrogen and atrazine contamination in the vadose zone in greater detail. On 8 fields, three 70' deep cores are taken on each field to determine the depth of contamination. On six additional fields, networks of nine 30' cores are taken on each field for nitrate and atrazine analysis.

This vadose zone testing has been carried out once in the pre- project phase and is planned to be repeated once post-project.

Watershed or Ambient Monitoring: Numerous monitoring programs are being carried out by State and regional entities. The Nebraska DEC has a routine program of vadose zone coring which currently includes some 15-20 stations in the project area. Soil cores are taken to 70' to determine if excess levels of nitrate or pesticides are present. Over the life of the project this program will be moving around the project area and may contribute to improved understanding of area-wide vadose zone conditions.

Several Natural Resources Districts (NRDs) operate programs relevant to the Demonstration project. The Tri-Basin NRD does regular root zone soil sampling for residual N before fertilizer application. The NRD also conducts a vadose zone sampling program to 30' on 19 sites in a special groundwater quality management area to determine downward movement of N. Sampling was done once 3 years ago, again 1 year ago, and will likely be repeated once or twice during the Demonstration project life.

The Upper Big Blue NRD also conducts a program of deep coring to the water table at eight sites within the District to estimate total nitrate load in the vadose zone. The program looks at both irrigated corn land and pasture land. Three of the corn sites are on Demonstration project sites.

The Lower Republican NRD is conducting an extensive program of vadose zone and groundwater testing. This program is taking place within the project boundaries on a large area which has documented groundwater nitrate problems. In cooperation with USGS, groundwater monitoring wells have been set up to evaluate nitrate and atrazine levels below agricultural land.

Finally, the Blue River Association of Groundwater Districts has been conducting groundwater testing of domestic wells since 1980. Over 200 domestic wells are tested twice a year for nitrate, with 20-30 samples submitted for pesticide scans. The Association also runs over 1,000 groundwater nitrate tests each year from walk- in samples, some from irrigation wells. The purpose of this program is to evaluate long-term trends in groundwater quality; nitrate levels have been generally increasing in domestic wells over the past 10 years.

Agricultural Management Monitoring: For each of the 33 demonstration farms, detailed records are being kept on irrigation water management, precipitation, and fertilizer applications. Tracking land treatments over the entire Demonstration area of over 2 million acres will be quite difficult. Some regional irrigation reporting systems exist and may provide useful information. SCS, for example, operates an irrigation water management reporting system. In addition, some of the NRDs and Groundwater Conservation districts help cooperating farmers maintain records on irrigation practices.

Most of the effort to collect land treatment information in the project area will focus on surveys of producers. Local CES personnel will conduct pre-project and post-project surveys to estimate adoption of management practices beyond the demonstration farms.

Modeling: Project staff plan to use the EPIC and NLEAP field-scale models to compare before-and-after simulated on-site nutrient and pesticide losses (edge of field and bottom of root zone) on its demonstration sites. The SRFR model is under study for predicting the distribution of applied water along irrigation furrows. NLEAP training was provided during FY 1991.

Project coordinators are *Richard Ferguson (CES/University of Nebraska) and Tom Hamer (SCS/Lincoln, NE).*

Group 3 Project: Surface Water and Groundwater, Nitrates and Pesticides, Rangeland

Seco Creek Demonstration Project, Texas

Abstract: Potential water quality problems in Seco Creek relate both to agricultural chemical use and to the unusual direct connection between surface and ground waters. The potential exists for pesticides, nutrients, sediments, and bacteria present in surface water to move directly into the sole aquifer serving San Antonio.

The Project objective is to demonstrate and transfer improved practices for grazing management, brush control, nutrient management, and pesticide management to farmers and ranchers. Specific practices will be demonstrated in plots which also include water quality monitoring. Additional ambient surface and ground water monitoring will provide a useful data base for project evaluation, but assessment of real project effects will be made difficult by the lack of current use impairment of the resource.

Introduction: This predominantly rangeland watershed of 170,000 acres overlies the rapidly recharging Edwards Aquifer, the sole source water supply for San Antonio. In the recharge area, land use is predominantly rangeland (150,000 acres). Beyond the recharge area is 16,000 acres of cropland of which 2,600 acres is irrigated.

In many cases, streams in the watershed enter the aquifer directly through open caves in the karst recharge zone, providing no filtration for surface waters entering the aquifer. In the upper reaches of the watershed, runoff flows into Seco Creek, which flows until it reaches the recharge area. Below this recharge zone, however, there is no flowing stream except during occasional extreme high flow events when the creek flows through to recharge downstream reservoirs.

Because surface waters can move directly into the Edwards Aquifer, the potential for polluting this aquifer with agricultural runoff, particularly from animal wastes, is considered a serious threat to all users. Groundwater is currently suitable for most purposes. Some water quality problems have been observed in Seco Creek, primarily related to sediment and associated nutrients and pesticides, as well as bacteria.

The goal of the Project is to demonstrate and transfer technology to farmers and ranchers that will protect the sensitive Edwards Aquifer and downstream reservoirs from

contamination with pesticides, fertilizer nutrients, and bacteria. Management practices and systems to be demonstrated include brush and grazing management, improved water use, fertilizer management, and pesticide management, and use of crops and crop rotations to reduce chemical use and control pests.

Site Level Monitoring: Water quality consequences of improved rangeland and cropland management will be evaluated using plot or small watershed studies. Water quality associated with various replicated treatments will be evaluated, both for chemical movement downward through the soil and losses in surface runoff. Nine edge-of-field sites are currently set up for brush management studies; site selection is underway for monitoring of fertilizer management plots.

Watershed or Ambient Monitoring: The Texas State Soil and Water Conservation Board and USGS are conducting a synoptic survey of domestic and farm water wells. All wells are being inventoried, and 20 will be sampled for nitrate and pesticides. USGS is also monitoring streamflow and stream chemistry with emphasis on event sampling. One station has historical data going back to 1974.

Agricultural Management Monitoring: Monitoring adoption of management practices by project participants as well as by non-cooperators is being conducted. Records from other programs such as the ASCS Agricultural Conservation Program (ACP) and the Great Plains Conservation Program (GPCP) are also being used.

The CAMPS system is being used to maintain records of land treatment. Not all conservation plans are yet entered in the system due to staffing limitations.

Modeling: Project staff plan to use EPIC and SWRRBWQ models to address sediment, nutrient, and pesticide questions at field and basin-scales, respectively. The models also track surface and leaching losses simultaneously which the hydrogeological situation dictates. Groundwater and surface water are directly connected. Basic training on EPIC and SWRRBWQ took place in FY 1991 along with a follow-up visit to make representative simulation runs.

Project coordinators are *Billy L. Harris (CES/Texas A & M University) and Gary Westmoreland (SCS/Temple, TX).*

Group 4 Project: Surface Water, Pesticides, and Irrigated Cropland

Rice Pesticide Demonstration Project, California

Abstract: The water quality problems and solutions are well documented in this 310,000-acre project. Site monitoring should show the effectiveness of the two BMP irrigation systems in reducing pesticide residues in tailwater from individual fields. Because of the relative simplicity of the area's hydrology, the consistency of agriculture, and the ability to track adoption of improved irrigation systems, findings from the demonstration sites may be extrapolated over the area with relative ease.

Introduction: Rice agriculture in the Sacramento Valley occurs on poorly drained clay soils. Rice is the only economically viable crop on these soils. The predominant irrigation method is continuous flood from sowing to harvest. Water flows from one field to another, and excess water enters a drain at the end of the field, where it may be recycled, reused in a downstream field, or discharged to the river.

The water quality problem is pesticide residue released to surface waters from rice irrigation. The main rice pesticides and active ingredient application rates are Molinate (4.0 lb/ac) and Bensulfuron (0.0625 lb/ac). Conventional systems which release used irrigation water directly into surface waters allowed pesticide residues into agricultural drains and waterways, killing fish and impairing drinking water supplies.

Pesticide levels in public waters have been reduced over 90% since 1983 through a combination of education, stringent regulatory programs, and changes in water management. The primary means of reducing residual pesticide levels in rice irrigation has been holding of irrigation tailwater on the rice field or on set-aside lands to allow natural degradation to occur. Future State water quality standards mandate ever-decreasing pesticide concentrations, and the decreasing availability of idle acreage for water holding will require improved practices for reducing pesticide residues in rice irrigation tailwater.

Site Level Monitoring: Several demonstration sites will be established in the watershed, directly comparing three irrigation systems: (1) Static irrigation system, (2) Recirculating system, and (3) Control. The first two represent state-of-the-art BMP irrigation systems, while the

third represents the current ponding system. The BMPs focus not just on reduced pesticide levels in irrigation tailwater but also on enhancing growers' ability to manage irrigation water while maintaining river standards. Since weather conditions influence holding times required for adequate pesticide degradation, the BMP irrigation systems should allow growers sufficient flexibility to meet performance goals even in bad-weather years.

Monitoring of these demonstration sites by University of California Cooperative Extension includes testing irrigation water entering and leaving the fields for molinate and carbofuran every 2 days during the irrigation season. Sampling is done according to California Department of Food and Agriculture (CDFA) are protocol, and pesticide analysis is performed by the manufacturers.

Watershed or Ambient Monitoring: There is also an extensive surface water monitoring network in place within the Demonstration area operated by the Department of Pesticide Regulation of the CDFA. This network dates back to a system which set threshold in-stream pesticide levels that would trigger requirements for extended tailwater holding time among growers. While this triggering mechanism is no longer used, the river monitoring network is sufficient to characterize ambient surface water pesticide concentrations. Eight stations are sampled for pesticides within the project area: three on the Sacramento River, two on the Colusa drain, one on Butte Slough, one on Sacramento Slough, and one on the Sacramento drinking water intake. These stations are sampled at least weekly during the historic irrigation water discharge season April-June, with biweekly sampling during the peak discharge season May-June.

Modeling: Simulation modeling is not planned as part of this project's evaluation methodology. The situation, flood-irrigated rice, is an exception to most of the ARS models. Project staff may wish to investigate EPA aquatic fate models -- Exposure Analysis Modeling System (EXAMS) and Water Quality Analysis Simulation Program 4 (WASP4) -- as possible tools to predict the rate of pesticide degradation under saturated conditions.

Project coordinators are *James Hill (CES/University of California) and Gary Bullard (SCS/Davis, CA).*

References

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USDA and Cooperating State Agencies. *Water Quality Program Plan to Support the President's Water Quality Initiative.* July 1989.

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Appendix A

Assessment Mandate

USDA Water Quality Program Plan

Page 22: "Evaluate mid-term success of first 8 Demonstration projects in 1992." "Evaluate the performance and effects resulting from first 8 Demonstration projects in 1994."

Page 25: "An evaluation requirement will be built into each research plan. ...reports will be evaluated to ensure that research results are both technically correct and responsive to practical problems. "Evaluations ... will assess whether agricultural chemical and production management systems ... are adopted by landowners; whether water quality models and monitoring data indicate that practices are achieving planned water quality goals."

Page 26: Planned Evaluation Reports: "Number of extended agrichemical and production management systems adopted and acres covered by each - annually 1991-1995." "Environmental loadings reduced and water quality changes induced ..." - annually 1991-1995."

"Evaluation of success of initial demonstration, hydrologic unit, (Section 319) and regional education and technical assistance projects in generating changes in agricultural practices and water quality - reports in 1993 and 1994."

ET&FA Monitoring and Evaluation Strategy

Pages 2-3: "Evaluate efforts of E&TA activities on the quality and quantity of ground and surface water resources." "Determine producer acceptance of the conservation practices recommended."

"ET&FA water quality efforts will be monitored and evaluated in terms of:

- o Reduction in use and application of agrichemicals and animal waste.
- o Conservation practices or systems of practices applied to remediate or prevent water quality impairment.
- o Change in chemical conditions of ground and surface waters.
- o Change in biologic conditions of ground and surface waters.
- o Change in physical conditions of surface waters.
- o Education, technical and financial assistance provided and related effectiveness in achieving producer adoption of improved practices."

Page 5: "A project Plan of Operations will be prepared for each project ... annually. This plan will contain a monitoring and evaluation element ...." "Monitoring and evaluation procedures ... will be addressed in detail for each project. Adoption of ... practices and direct reductions in use of agrichemicals will be recorded ... Change in loadings, and ultimately, changes in chemical, biological, or physical conditions of ground and surface water will also be measured where possible ...."

Page 6: "A national level evaluation for eight Demonstration Projects and a selected number of Hydrologic Unit Areas will be reported ...."

Page 7: In summary, ET&FA monitoring and evaluation will be done a) by each project in their annual project report, and b) by a national-level assessment team for 8 Demonstration Projects and selected Hydrologic Unit Areas. In both instances, it will include: 1) monitoring and evaluation of reduction in use and application of agrichemicals and animal waste; 2) predicting offsite effects (edge of field and bottom of root zone); 3) monitoring change in ... water resources ... resulting from treatment activities.

APPENDIX B

ACRONYMS

Agencies and Programs:

ARS - USDA Agricultural Research Service

ASCS - USDA Agricultural Stabilization and Conservation Service

CES - Cooperative Extension Service

DP - ET&FA Demonstration Project

EPA - U.S. Environmental Protection Agency

ERS - USDA Economic Research Service

ES - USDA Extension Service

ET&FA - USDA Working Group on Water Quality's Education, Technical, and Financial Assistance Committee

HUA - ET&FA Hydrologic Unit Area

MSEA - Management Systems Evaluation Areas

NTC - SCS National Technical Center

SCS - USDA Soil Conservation Service

TVA - Tennessee Valley Authority

USGS - U.S. Geological Survey

Selected Models:

AGNPS - Agricultural NonPoint Source

CMLS - Chemical Movement in Layered Soils

CREAMS - Chemicals, Runoff, Erosion from Agricultural Management Systems

EPIC - Erosion Productivity Impact Calculator

GIS - Geographic Information System

GRASS - Geographic Resources Analysis Support System

GLEAMS - Groundwater Loading Effects of Agricultural Management Systems

NLEAP - Nitrogen Leaching and Economic Analysis Package

NPURG - National Pesticide/Soils Database and User Decision Support System for Risk Assessment of Ground and Surface Water Contamination

SWRRBWQ - Simulator for Water Resources in Rural River Basins Water Quality

Other:

BMP - Best Management Practice

BOD - Biological oxygen demand

CAMPS - SCS Computer Assisted Management and Planning System

DO - Dissolved oxygen

ICM - Integrated Crop Management

IPM - Integrated Pest Management

QA/QC - Quality assurance/quality control

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